

6. 54. e. 75
A LEARNED
TREATISE OF
Globes,

Both Cœlestiall and
Terreſtriall: with their
ſeverall uſes.

Written firſt in Latine, by
M^r Robert Hues: and by him
ſo Publiſhed.

Afterward Illustrated with Notes, by
Io. Iſa. PONTANUS.

And now laſtly made Engliſh, for the
benefit of the Vnlearned.

By John Chilmead M^r A. of
Chriſt-Church in OXON.

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To the Reader.

THat nothing is at once brought forth, and perfected, is an observation wee may make, as from other things, so in a more especiall manner from Arts and Sciences. For (not to speake any thing of the rest, which yet have all of them in succession of times, had their accessions of Perfection) if wee but take the Astronomicall writings of Aratus, or of Eudoxus, (according to whose observations Aratus is reported by Leontius Mechanicus to have composed his Phaenomena) and compare the same with the later writings of Ptolomy; what errors and imperfections shall wee meet withall? And in the Geographicall workes of the Ancients, whether we compare them among themselves, the later with the former; or either of them with the more accurate descriptions of our Moderne Geographers: how many things shal we meet withall therein, that need either to be corrected as erroneous, or else
At x supplied

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supplied as defective? There shall wee finde Strabo every where harshly censuring the extravagancies of Eratosthenes, Hipparchus, Polybius, and Posidonius; Authors among the Ancients of very high esteeme. For as for Pytheas, Euthemeres, Antiphanes, & those Indian Historiographers, Megasthenes, Nearchus, and Daimachus, whose writings are stuffed with so many fabulous idle relations, he accounts them unworthy his censure. In like manner Marinus Tyrius, however a most diligent Writer, is yet hardly dealt withall by Ptolomy. And even Ptolomy himselfe, a man that for his great knowledge and experience may seeme to have excelled all those that went before him: yet if a man shall but compare his Geographical Tables with the more perfect discoveries of our later times: what defects and imperfections shall hee there discover? Who sees not his errors in the boundas he sets to the Southerne parts of Asia and Africa? How imperfect are his descriptions of the Northerne Coasts of Europe? These errors of Ptolomy, and of the Ancient Geographers, have now at length beene discovered by the late Sea voyages of the Portugalls, and English: the Southerne Coasts of Africa and Asia,

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Asia, having beene most diligently searched into by the Portugalls; as the Northerne parts of Europe, have in like manner beene by our owne Country-men. Among whom, the first that adventured on the discovery of these parts, were, Sir Hugh Willoughby, and Richard Chancellor: after them, Stephen Borough. And farther yet then either of these, did Arthur Pet, and Charles Jackman discover these parts. And these voyages were all undertaken by the instigation of Sebastian Cabot: that so, if it were possible, there might bee found out a nearer passage to Cathay and China: yet all in vaine; save only that by this meanes a course of trafficke was confirmed betwixt us and the Moscovite.

When their attempts succeeded not this way; their next designe was then to try, what might bee done on the Northerne Coasts of America: and the first undertaker of these voyages was Mr. Martin Frobisher: who was afterward seconded by Mr. Iohn Davis. By meanes of all which Navigations, many errorrs of the Ancients, and their great ignorance was discovered.

But now that all these their endeavours succeeded not, our Kingdome at that time

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being well furnished in ships, and impatient of idlenesse: they resolved at length to adventure upon other parts. And first Sir Humphry Gilbert with great courage and Forces attempted to make a discovery of those parts of America, which were yet unknowne to the Spaniard: but the successe was not answerable. Which attempt of his, was afterward more prosperously prosecuted by that honorable Gentleman Sir Walter Rawleigh: by whose meanes Virginia was first discovered unto us, the Generall of his Forces being Sir Richard Greenville: which Countrey was afterwards very exactly surveighed and described by Mr. Thomas Harriot.

Neither have our Countrey-men within these limits bounded their Navigations. For Sir Francis Drake, passing through the straites of Magellane, and bearing up along the Westerne Coasts of America, discovered as farre as 50. degrees of Northerne Latitude. After whom, Mr. Thomas Candish tracing the same steps, hath purchased himselfe as large a monument of his fame with all succeeding ages. I shall not need to reckon with these our Countreyman Sir Iohn Mandevil, who almost 300. yeares since, in a 33. yeares voyage by land, tooke a strict
view

To the Reader.

view of all India, China, Tartary and Persia, with the Regions adjoining.

By these, and the like expeditions by Sea, the matter is brought to that passe, that our English Nation may seeme to contend even with the Spaniard and Portugall himselfe, for the glory of Navigation. And without all doubt, had they but taken along with them a very reasonable competency of skill in Geometry, and Astronomy: they had by this gotten themselves a farre more honourable name at Sea, then they. And indeed, it is the opinion of many understanding men, that their endeavours have taken the lesse effect, meerely through ignorance in these Sciences. That therefore there might be some small accrument to their study and paines, that take delight in these Arts; I have composed this small Treatise: which that it may be for their profit, I earnestly desire. Farewell.



The Contents of the Chapters of
this T R E A T I S E.

THe Preface : wherein is shewed the Antiquity, and excellency of *Globes*, in comparifon of all other Instruments, as being of a forme most apt to expresse the figure of the Heavens and Earth. The roundnes of the Earth is defended against *Patricius*. The height of Hilles, how much it may detract from the roundnesse of the Earth.

The first P A R T.

Chapter 1.

WHa t a *Globe* is, with the parts thereof; and of the Circles without the *Globe*: What the Horizon is, with the things described thereon in a Materiall *Globe*. What the Meridian is, the Poles, and *Axis*; as also the Houre-circle and Index.

Chap. 2.

Of the circles which are described on the superficies of *Globes*. Of the *Aequator* or *Aequinoctiall* circle. What a day is, both Naturall, and Artificiall: as also of Houres, both

A TABLE

both Equall, and Vnequall. Of the Zodiacke, and Eccliptick. What a yeare is, and the Indeterminate limits thereof: together with the diverse opinions of Authors concerning the same; as also many of their errours. What the *Aequinoctium*, and Solstices are; with changing of their places, and Anticipation in the Calendar, confirmed by many observations. The error of *Sosigenes*, and *Iulius Caesar*, in designing the place of the *Aequinoctium*. Of the Colures. The longitude and latitude of the fixed Starres are proved by observations, to have beene altered. A place of *Ptolomy*, lib. 1. cap. 7. *Geograph.* is vindicated from the injury of his interpreters, and confirmed by the authority of *Strabo*. Of the Tropickes: with the changing of their declination. What the Arcticke and Antarcticke Circles are: Of the Verticall Circles, and Quadrant of Altitude.

Chap. 3.

Of the three positions of Sphere, Right, Parallel, and Oblique: with their severall affections.

Chap. 4.

Of the Zones, and their number. The vaine opinions of the Ancients, concerning the temperature of the Zones, are rejected; both by the Testimonies of some of the Ancients themselves, as also by the experience of later times.

Chap. 5.

Of the *Amphiscij*, *Periscij*, and *Heteroscij*.

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Chap. 6.

Of the *Periæci*, *Antæci*, and *Antipodes*, compared to each other.

Chap. 7.

Of *Climates*, and *Parallels*.

The second P A R T.

Chap. 1.

OF such things as are proper to the *Cœlestiall Globe*: as namely of the *Stars*. And first of the *Planets*, or wandering *Stars*.

Chap. 2.

Of the fixed *Starres*, and their *Constellations*.

Chap. 3.

Of the *Constellations* of the *Northerne Hemisphere*.

Chap. 4.

The *signes* of the *Zodiacke*: and first of the *Northerne*.

Chap. 5.

The *Constellations* of the *Southerne Hemisphere*: and first of those in the *Zodiacke*.

Chap. 6.

Of the rest of the *Constellations* of the *Southerne Hemisphere*.

Chap. 7.

Of the other *Stars* which are not expressed in *Globes*. Why the *Stars* appeare sometimes in greater number, then at other times, and sometimes greater, and at other times less: with

A T A B L E

with the confutation of some vaine opinions concerning the same. The idle relations of *Americus Vespufius*, *Cardan*, and *Patricius*, concerning the extraordinary greatneffe of the Stars about the South Pole, are refuted out of the Authors owne experience,

The third P A R T.

Chap. 1.

THE Geographickall description of the Terrestriall Globe, with the parts of the world that are yet knowne. The errors of *Ptolomy*, concerning the Southerne bounds of *Africa* and *Asia*, as also of the Northerne limits of *Europe*, are condemned, out of the Writings of the Ancients, and various experience of later Writers.

Chap. 2.

Of the compasse of the Earth, and the measure of a Degree: with diverse opinions concerning the same of the *Greekes*; as namely, *Eratosthenes*, *Hipparchus*, *Posidonius*, *Cleomedes*, and *Ptolomy*: as also of the *Arabians*, *Italians*, *Germans*, *English*, and *Spanish*. *Posidonius*, and *Eratosthenes* are confuted out of their owne observations and propositions. *Ptolomyes* opinion is preferred before the rest, and he freed from the Calumnies of *Maurolycus*: who is also taxed, in that without cause favouring *Posidonius*, he unjustly condemnes *Ptolomy*.

The Fourth P A R T.

Chap. 1.

HOW to finde out the longitude, latitude, distance, and angle of position or situation of any places expressed in the Terrestrial Globe.

Chap. 2.

Of the Latitude of any place.

Chap. 3.

How to finde the distance, and angle of position of any two places.

Chap. 4.

To finde the Altitude of the Sunne, or Starres.

Chap. 5.

To finde the place and declination of the Sunne for any day given.

Chap. 6.

To finde the Latitude of any place, by observing the Meridian altitude of the Sunne, or Starres.

Chap. 7.

How to find the Right and Oblique Ascension of the Sunne, and Stars, for any Latitude of Place and Time.

Chap. 8.

How to find the Horizontall difference betwixt the Meridian and the verticall circle of the Sunne, or any other Starre, which they call the *Azimuth*, for any time, or place assigned.

Chap.

TABLE

Chap. 9.

To find the houre of the day, as also the amplitude of rising and setting of the Sunne, and Starres, at any time and latitude of place.

Chap. 10.

Of the threefold rising and setting of Stars.

Chap. 11.

How to finde the beginning and end of the Twilight, for any latitude of place and time.

Chap. 12.

To find for any latitude of place, and time, the length of the Artificiall day, or night; or the quantity of the Sunnes Parallel that remaines above the Horizon, and that is hid beneath it: and to performe the same by any other Starre.

Chap. 13.

To finde the houre of the Day and Night, both Equall and Vnequall, for any time and latitude of place.

Chap. 14.

To finde the longitude, latitude, and declination of the fixed Stars, as they are expressed in the *Globe*.

Chap. 15.

To find the declination of the Needle from the true Meridian, which they commonly call, *the Variation of the Compasse*, for any latitude assigned: Where the errours of those are discovered, who assigne to the Magneticall Needle a certaine Meridian, and fixed point which it alwayes respects; and that affirme this change of variation to be regular. All which
vaine

of the Contents.

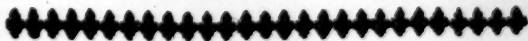
vaine conjectures of theirs, and ungrounded Hypotheses, are refuted both by more certaine observations of others, as also of the Author himselfe.

Chap. 16.

How to make a Sun Diall, by the helpe of the *Globe*, for any latitude of place.

The fifth and last P A R T.

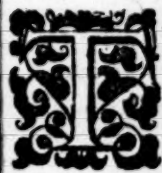
OF the *Rumbes* that are described upon the Terrestriall *Globe*: wherein their nature, Originall, and use in Navigation is declared.



The



The Preface.



Here are two kinds of Instruments;
by which Artificers have concei-
ved, that the figure of this so beau-
tifull and various fabricke of the
whole Universe, might most apt-
ly be expressed, and, as it were, at
once presented to the view. The one, exhibiting this
Idea in a round solid, is called a Globe, or Sphere:
The other, expressing the same in a Plaine, they
tearme a Planisphere, or Map. Both of which
having been long since invented by the Ancients,
have yet even to our times in a continued succes-
sion, received still more ripenesse and perfection.
The Sphere or Globe, and the use thereof, is re-
ported by Diodorus Siculus to have been first
found out by Atlas of Libya: Whence afterward
sprung the Fable of his bearing up the Heavens
with his Shoulders. Others attribute the inventi-
on of the same to Thales. And it was afterward
brought to perfection by Crates, (of Whom Strabo
makes mention) Archimedes, and Proclus;
but most of all by Ptolomy; according to whose
rules and observations especially, succeeding times
composed their Globes, as Leontius Mechanicus
affirmes. And now there hath been much perfe-

TIGHTLY
BOUND.

The Preface.

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The Preface.

Etion added to the same in these our later times, by the industry and diligence of Gemma Frisius, and Gerardus Mercator ; as it may appear by those Globes that were set forth at London, Anno 1593. so that now there seemes not to be any thing that may be added to them. The Planisphere indeed is a fine invention, and hath in it wonderful variety of Workmanship, if so be that the composition of it be rightly deduced out of Geometricall and Opticall principles : and it wants not its great delightfulness, and beauty also. But yet that Other, being the more ancient, hath also the priority in Nature, and is of the most convenient forme; and therefore more aptly accommodated for the understanding and fancy, (not to speake any thing of the beauty and gracefulness of it) for it representeth the things themselves in proper genuine figures. For as concerning the figure of the Heavens, whether it were round, was scarcely ever questioned by any. So likewise touching the figure of the Earth, notwithstanding many and sundry opinions have been broached among the ancient Philosophers, some of them contending for a plaine, others an hollow, others a Cubicall, and some a Pyramidall forme : yet this opinion of its Roundnesse, with greatest consent of reason at length prevailed, the rest being all exploded. Now we as firme it to be round, yet so, as that wee also admit of its inequalities, by reason of those so great eminencies of hills, and depression of vallies. Eratosthenes, as he is cited by Strabo in his first booke, saith, that the fashion of the earth is like that of a Globe, not so exactly round as an artificiall Globe

Strabo lib.
I. Geogr.

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is, but that it hath certaine inequalities. The earth cannot be said to be of an exact orbicular forme; by reason of so many high hilles, and low plaines: as Pliny rightly obserues. And Strabo also in his first book of his Geography; saith, that the Earth and the Water together make up one sphericall body, not of so exact a forme, as that of the Heavens; although not much unlike it. This assertion of the roundnesse of the Earth, with the intervening Sea, is confirmed also by these reasons. For first, that it is round from East to West is proved by the Sun, Moon; and the other Starres, which are seen to rise and set first with those that inhabite more Eastwardly, and afterward with them that are farther West. The Sun riseth with the Persians that dwell in the Easterne parts, foure houres sooner then it doth with those that dwell in Spaine more Westward: as Cleomedes affirmes. The same is also proved by the observing of Eclipses, especially those of the Moon; which although they happen at the same time, are not yet observed in all places at the same houre of the day or night, but the houre of their appearing is later with them that inhabite Eastward, then it is with the more Westerne people. An Eclipse of the Moon, which Pto- lomy reports lib. 1. Geogr. cap. 4. to have been seen in Arbela, (a towne in Assyria,) at the first houre of the night; the same was obserued at Carthage at the second houre. In like manner an Eclipse of the Sun, which was observed in Campania to be betwixt 7 and 8 of the clock; was seen by Corbulo, a Captaine in Armenia, betwixt 10 and 11, as it is related by Pliny. Now that it is

Pliny lib. 1.
cap. 21.

Cleomed.
lib. 1. cap. 8.

Ptolom.
Geog. lib. 1.
cap. 4.

Plin. lib. 7.
cap. 70.

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also of a sphericall figure from North to South, may be clearly demonstrated by the risings, settings, elevations and depressions of the Starres and Poles. The bright starre that shines so resplendently in the upper part of the sterne of the Ship Argo, and is called by the Greekes $\alpha\beta\gamma\delta\epsilon\zeta$, is scarcely to be seen at all in Rhodes, unlesse it be from some eminent high place: yet the same is seen very plainly in Alexandria, as being elevated above the Horizon about the fourth part of a figure: as Proclus affirmes in the end of his book de Sphaera. For I read it, *Conspiciuè cernitur*; not as it is commonly, *Porius non cernitur*: notwithstanding that both the Greek text, and also the Latine translation are against it. Another argument may be taken from the figure of the shadow in the Eclipse of the Moon, caused by the interposition of the Earths opacous body: Which shadow being sphericall, cannot proceed from any other then a round globous body: as it is demonstrated unto us out of Opticall principles. But this one reason is beyond all exception: that those that make toward the land at Sea, shall first of all descry the tops of the hilles onely, and afterward, as they draw nearer to shore, they see the lower parts of the same by little and little: Which cannot proceed from any other cause, then the gibbositie of the Earths superficies.

As for those other opinions of the hollow, Conicall, Pyramidall, and plaine figure of the Earth, you have them all largely examined both in Theon, (Ptolomies Interpreter) Cleomedes, and almost in all our ordinary authours of the Sphere, together

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Whether with the reasons why they are rejected.
That old conceit of the plainnesse of the Earths
superficies is againe now at last, tanquam Cram-
recocta, set forth in a new dresse, and thrust
on us by Franciscus Patricius; Who by some
cold arguments, & misunderstood experiments,
deavours to confirme his owne, and consequently
overthrow that other received opinion of the
spherical figure of the Earth. I shall onely light-
touch at his chiefest arguments; my present
purpose and intension suffering me not to insist long
on the confutation of them. And first of all, the
great height of hills, and the depression of vallies,
much disagreeing from the evennesse of the plain
parts of the Earth, seem to make very much a-
gainst the roundnesse of the Earth. Who can heare
with patience, saith he, that those huge high moun-
taines of Norway, or the mountaine Slotus,
which lies under the Pole, and is the highest in the
world, should yet be thought to have the same su-
perficies with the Sea lying beneath it? This ther-
fore being the chiefest reason, that may seem to o-
verthrow the opinion of the Earth and Seas ma-
king up one spherical body; let us examine it a
little more nearly, and consider, how great this in-
equalitie may be, that seemes to make so much a-
gainst the evennesse of this Terrestrial Globe.
Many strange, and almost incredible things are
reported by Aristotle, Mela, Pliny, and Solinus,
of the unusuall height of Athos, an hill in Maco-
lonia, and of Casius in Syria, as also of another of
the same name in Arabia, and of the mountaine
Caucasus. And among the rest, one of the most mi-
raculous

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raculous things which they have observed of the mountaine Athos, is, that whereas it is situated in Macedony, it casts a shadow into the market place at Myrrhina, a towne in the Island Lemnos; from whence Athos is distant 86. miles. But for as much as Athos lies Westward from Lemnos, as may appeare out of Ptolomies Tables, no marvaile that it casts so large a shadow: seeing that wee may observe by daily experience, that as well when the Sun riseth, as when it setteth, the shadowes are alwayes extraordinary long. But that which Pliny, and Solinus report of the same mountaine, I should rather account among the rest of their fabulous Stories; where as they affirme it to be so high, that it is thought to be above the region of the aire, whence the raine is wont to fall. And this opinion (say they) was first groundd upon a report that there goes, that the ashes which are left upon the Altars on the top of this hill, are never washed away, but are found remaining in heapes upon the same. To this may be added another testimony, out of the Excerpts of the seventh booke of Strabo, where it is said, that those that inhabite the top of this mountaine, doe see the Sun three houres sooner, then those that live neare the Sea side. The height of the mountaine Caucasus is in like manner celebrated by Aristotle, the top whereof is enlightened by the Sunnes beames the third part of the night both morning and evening. No lesse fabulous is that which is reported by Pliny and Solinus of Casius in Syria from whose top the Sun rising is discovered about the fourth watch of the night: which is also related by Mela of that
other

ther Casius in Arabia. But that all these relations are no other then meere fables, is acutely and solidly proved by Petrus Nonius, out of the very principles of Geometry. As for that which Eustathius writes, that Hercules pillars, called by the Greeks Calpe and Abenna, are celebrated by Dionysius Periegetes for their miraculous height, is plainly absurd and ridiculous. For these arise not above an hundred elles in height, which is but a furlong: whereas the Pyramids of Egypt are reported by Strabo to equall that height; and some trees in India are found to exceed it: if wee may credit the relations of those Writers, who in the same Strabo affirme, that there growes a tree by the river Hyarotis, that casteth a shadow at noon five furlongs long.

Those fabulous narrations of the Ancients, are seconded by as vaine reports of our moderne times. And first of all Scaliger writes, from other mens relation, that Tenariff, one of the Canary Islands, riseth in height fiftene leagnes, which amount to above sixtie miles. But Patricius not content with this measure, stretcheth it to seventie miles. There are other billes in like manner cryed up for their great height; as namely the mountaine Andi in Peru, and another in the Isle Pico among the Azores Islands: but yet both these fall short of Tenariff. What credit these relations may deserve, we will now examine. And first for Tenariff, it is reported by many writers to be of so great a height, that it is probable the whole world affoordes not a more eminent place; not excepting the mountaine Siotus it selfe; which whether ever any other mor-

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tall man hath seen, besides that Monke of Oxford (who by his skill in Magicks compassed himself into the utmost Northerne regions, and tooke a view of all the places about the Pole, (as the Story hath it) is more then I am able to determine. Yet that this Isle cannot be so high as Scalliger would have it, we may be the more bold to beleeve, because that the tops of it are scarcely ever free from snow: so that you shall have them covered all over with snow all the yeare long, save onely one, or, at the most, two moneths in the midst of summer: as may appeare out of the Spanish Writers. Now that any snow is generated 60 or 70 miles above the plaine superficies of the Earth and Water, is more then they will ever perswade us: seeing that the highest vapours never rise above 48 miles above the Earth, according to Eratosthenes his measure; but according to Ptolemy, they ascend not above 41 miles. Notwithstanding Cardan, and some other profest Mathematicians, are bold to raise them up to 288 miles; but with no small staine of their name have they mixed those trifles With their other writings. Solinus reports that the tops of the mountaine Atlas reacheth very neare as high as the circle of the Moon: but he betrayeth his own error, in that he confesseth that the top of it is covered with snow, and shineth with fires in the night. Not unlike to this, are those things which are reported of the same mountaine, and its height, by Herodotus, Dionysius Afer, and his scholiast Eustathius: whence it is called in Authours, Cœlorum columnen, the pillar that beares up the Heavens.

But

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But to let passe these vaine prodigious relations :
 let us come to those things that seem to cary a
 greater shew of truth. Eratosthenes found by
 Dioptricall instruments, and measuring the di-
 stances betwixt the places of his observation, that
 a perpendicular, drawen from the top of the highest
 mountaine, downe to the lowest bottome or vally,
 did not exceed ten furlongs. Cleomedes saith,
 that there is no hill found to be above fifteene fur-
 longs in height : and so high as this, was that vast
 steepe rocke in Bactriana, which is called Sisimi-
 tra Petra, mentioned by Strabo in the 11. booke
 of his Geography. The toppes of the Thessalian
 mountaines are raised to a greater height by Soli-
 nus, then ever it is possible for any hill to reach.
 Yet if we may beleewe Pliny, Dicæarchus being
 employed by the Kings command in the same busi-
 ness, found that the height of Pelion, which is the
 highest of all, exceeded not 1250. pases, which is
 but ten furlongs. But to proceed yet a little fur-
 ther, least we should seem too sparing herein, and to
 restraine then within narrower limits then wee
 ought : wee will adde to the height of hilles, the
 depth also of the Sea. Of which the illustrious Iu-
 lius Scaliger in his Exercitation against Cat-
 dan, writeth thus. The depth of the Sea (saith he)
 is not very great : for it exceeds 80. pa-
 ses, in most places it is not 20. pases, and in many
 places not above 6. in few places it reacheth 100.
 pases, and very seldome, or never exceeds this num-
 ber. But because that this fallies by experience of
 the truth, as is testified by the daies, he the depth of
 those that passe the Seas : let us make the

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(who by his ski
selfe into the air
a view of all th
Story hath it) i
mine. Yet that
liger would ha
beleewe, becau
wer free from su
covered all over
onely one, or, at
of summer : as
Writers. Now
70 miles above
and Water, is 1

MIS-PRI ORIGIN

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this, are those things which are reported of the
same mountaine, and its height, by Herodotus,
Dionysius Afer, and his scholiast Eustathius :
whence it is called in Authours, Cælorum co
lumen, the pillar that beares up the Heavens.

But

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to cary a
ces found by
uring the di-
vation, that
of the highest
ome or vally,
medes saith,
e fifteene fur-
was that vast
called Sisimi-
the 11. booke
the Thessalian
height by Soli-
hill to reach.
earchus bring

Let it be my
mployed by the Kings command in the same busi-
ness, found that the height of Pelion, which is the
highest of all, exceeded not 1250. pases, which is
highest. But to proceed yet a little fur-
ther, least w. should seem too sparing herein, and to
restraine then. all adde to the height of hilles, the
ought: wee will. Of which the illustrious Ju-
depth also of the S& 8. Exercitation against Car-
lius Scaliger in his 3. depth of the Sea (saith he)
dan, writeth thus. The seldome exceeds 80. pa-
is not very great: for it 20. pases, and in many
ses, in most places it is not. ces it reacheth 100.
places not above 6. in few pla. exceeds this num-
pases, and very seldome, or never very far short of
ber. But because that this falles dy experience of
the truth, as is testified by the dan, he the depth of
those that passe the Seas: let us ma. the

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the Sea equall to the height of mountaines : so that suppose the depth thereof to be 10. furlongs, which is the measure of the Sardinian Sea, in the deepest places as Posidonius in Strabo affirmes. Or if you please, let it be 15. furlongs, as Cleomedes, and Fabianus, cited by Pliny lib. 2. c. 102. will have it. (For Georg. Valla in his interpretation of Cleomedes, deales not fairely with his author, where he makes him assigne 30. furlongs to be the measure of the Seas depth.) These grounds being thus laid, let us now see what proportion the height of hilles may beare to the Diameter of the Whole Earth: that so we may hence gather, that the extuberancy of hilles are able to detract little or nothing from the roundnesse of the Earth; but that this excrescency will be but like a little knob or dust upon a ball, as Cleomedes saith. For if wee suppose the circumference of the whole earth to be 180000. furlongs, according to Ptolomies account, (neither did ever any of the Ancients assigne a lesse measure then this; as Strabo witnesseth:) the Diameter thereof will be, (according to the proportion betwixt a circle and its Diameter found out by Archimedes,) above 57272. furlongs. If then wee grant the highest hilles to be ten furlongs high, according to Eratosthenes and Dicarchus; they will beare the same proportion to the Diameter of the Earth, that is, betwixt 1. and 5727. (Peucerus mistakes himselfe, when he saith, that the Diameter of the Earth to the perpendicular of ten furlongs is, as 18000. to 1. for this is the proportion it beareth to the whole circumference, and not

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not the Diameter. Or suppose the toppes of the highest hilles to ascend to the perpendicular of fiftene furlongs, as Cleomedes would have it: the proportion then will be of one to 3818. Or if you please, let it be thirtie furlongs, of which height is a certaine rocke in Sogdiana, spoken of by Strabo, in the eleventh Booke of his Geography, (notwithstanding Cleomedes is of opinion, that a perpendicular drawne from the top of the highest hill, to the bottome of the deepest Sea, exceeds not this measure:) the proportion will be no greater, then of one to 1908. Or let us extend it yet farther, if you will, to foure miles, or thirty-two furlongs, (of which height the mountaine Casius in Syria is reported by Pliny to be,) the proportion will yet be somewhat lesse then of one to 1789. I am therefore so farre from giving any credit to Patricius his relation of Tenariffes being seventy-two miles high, (unlesse it be measured by many oblique and crooked turnings and windings: in which manner Pliny measureth the height of the Alpes also to be fiftie miles;) as that I cannot assent to Alhazen, an Arabian, who would have the toppes of the highest hilles to reach to eight Arabian miles, or eighty furlongs, as I thinke: neither yet to Pliny, who in his quarto lib. cap. 11. affirms the mountaine Maximus to be six milos in height: and I can scarcely yeeld to the same Pliny, when as he speakes of other hilles foure miles in height. And whosoever should affirme any hill to be higher then his, though it were Mercury himselfe, I should hardly

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hardly believe him. Thus much of the bright of
billes, which seemed to derogate from the round-
nesse of the Terrestriall Globe. Patricius pro-
ceeds, and goes about to prove that the water
also is not round or sphericall. And he bor-
roweth his argument from the observations of
those that conveigh or levell waters, who finde
by their Dioptricall Instruments; that waters
have all an equall and plaine superficies, ex-
cept they be troubled by the violence of windes.
On the contrary side, Eratosthenes in Strabo
affirmes, that the superficies of the Sea is in
some places higher, then it is in other. And he
also produceth, as assertors of his ignorance,
those Water-levellers, who being employed by De-
metrius about the cutting away of the Isth-
mus, or necke of land betwixt Peloponesus and
Greece; returned him answere, that they found
by their Instruments, that that part of the Sea
which was on Corinth's side, was higher then
it was at Cenchræe. The like is also storied of
Sesostris, one of the Kings of Ægypt, who
going about to make a passage out of the Medi-
terranean into the Arabian gulf, is said to
have desisted from his purpose, because he found
that the superficies of the Arabian gulf was
higher then was the Mediterranean: as it is
reported by Aristotle in the end of his first booke
of Meteors. The like is also said in the same
place by the same Author to have happened af-
terward to Darius. Now whether the Archi-
tects or Water-levellers, imployed by Deme-
trius, Sesostris, and Darius, deserve more cre-
dit,

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dit, then those whom Patricius nameth, I shall not much trouble my selfe to examine. Yet Strabo inveigheth against Eratosthenes for attributing any such eminencies and depressions to the superficies of the Sea. And Archimedes his doctrine is, that every humid body, standing still and without disturbance, hath a Sphericall superficies, whose center is the same with that of the earth. So that wee have just cause to reject the opinions, both of those that contend that the superficies of the Sea is plaine; as also of those that will have it to be in some places higher then in other. Although wee cannot in reason but confesse, that so small a portion of the whole Terrestriall Globe, as may be comprehended within the reach of our sight, cannot be distinguished by the helpe of any Instruments from a plaine superficies. So that we may conclude Patricius his argument, which he alleadgeth from the experience of Water-conveighers, to be of no weight at all.

But hee goes on, and labours to prove his assertion from the elevation and depression, rising and setting of the Poles and Starres, which are observed daily by those that traverse the Seas: all which, he saith, may come to passe, although the surface of the water were plaine. For if any Starre be observed, that is in the verticall point of any place; which way soever you travell from that place, the same Starre will seeme to bee depressed, and abate something of its elevation, though it were on a plaine superficies. But there is something more in it then Patricius takes notice of. For if wee goe an equall
measure

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measure of miles either toward the North, or toward the South; the elevation or depression of the Starre will alwayes bee found to bee a quall: Which that it can possibly bee so in a plaine superficies, is more then bee will ever be able to demonstrate. If wee take any Starre situate neare the Equator, the same when you have removed thence 60. English miles, will be elevated about a degree higher above the Horizon, whether the Starre be directly over your head, or whether you depart thence, that so it may bee depressed from your Zenith, for 30. or 50. or any other number of degrees. Which that it cannot thus bee on a plaine superficies, may bee demonstrated out of the principles of Geometry. But yet me thinkes, this one thing might have perswaded Patricius (being so well versed in the Histories of the Spanish Navigations, as his writings sufficiently testifie) that the superficies of the Sea is not plaine; because that the Ship called the Victory, wherein Ferdinand Magellane losing from Spaine, and directing his course toward the Southwest parts, passed through the Straits, called since by his name, and so touching upon the Cape of good hope, having encompassed the whole world about, returned againe into Spaine. And here I shall not need to mention the famous voyages of our owne Countrymen, Sir Francis Drake, and Master Thomas Candish, not so well knowne perhaps abroad; which yet convince Patricius of the same error. And thus have wee lightly touched the chiefe foundations

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ons that his cause is built upon : but as for those ill understood experiments, which he brings for the confirmation of the same. I shall let them passe, for that they seeme rather to subvert his opinion, then confirme it.

Thus having proved the Globe of the Earth to be of a Sphericall figure, seeing that the Eminency of the highest Hills bath scarcely the same proportion to the Semidiameter of the Earth, that there is betwixt 1. and 1000. which how small it is, any one may easily perceive: I hold it very superfluous to goe about to prove, that a Globe is of a figure most proper and apt to expresse and represent the fashion of the Heavens and Earth, as being most agreeable to Nature, easiest to bee understood, and also very beautifull to be hold.

Now in materiall Globes, besides the true and exact description of places, which indeed is the chiefeft matter to bee considered; there are two things especially required. The first whereof is the magnitude and capacity of them; that so there may bee convenient space for the description of each particular place or region: the second is the lightnesse of them; that so their weight be not cumbersome. Strabo in his eleventh booke, would have a Globe to have tenne foot in Diameter, that so it might in some reasonable manner admit the description of particular places. But this bulke is too vast to bee conveniently dealt withall. And in this regard, I thinke that those Globes, of which I intend to speake in this ensuing discourse, may justly
be

bee preferred before all other that have been
set forth before them; as being more capaci-
ous then any other: for they are in Diameter
two foot, and two inches: whereas Mercator's
Globes, (which are bigger then any other ever
set forth before him,) are scarcely sixteene in-
ches Diameter. The proportion therefore of
the superficies of these Globes to Mercator's,
will bee as 1. to 2³. and somewhat more. Ev-
ry Countrey therefore in these Globes will be
above twise as large as it is in Mercator's:
so that each particular place may the more ea-
sily bee described. And this I would have to
bee understood of those great Globes made by
William Saunderfon of London; concerning
the use of which especially we have written this
discourse. For he hath set forth other smaller
Globes also, which as they are of a lesser bulk
and magnitude, so are they of a cheaper price:
that so the meaner Students might herein also be
provided for. Now concerning the Geographi-
call part of them, seeing it is taken out of the
newest Charts and descriptions; I am bold to
think them more perfect then any other: how ever
they want not their errors. And I thinke it may
bee the Authors glory to have performed thus
much in the edition of these Globes. One thing by
the way you are to take notice of: which is, that
the descriptions of particular places are to bee
sought for elsewhere; for this is not to bee ex-
pected in a Globe. And for these descriptions of
particular Countreies, you may have recourse to
the Geographicall tables of Gerardus Mercator,

whose

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whose diligence and industry in this regard seemes
to exceed all other before him. To him, therefore
we referre you.

PONT. STRABO in the place above
cited by the Author, speakes of a *Globe* of that
bignesse, not such an one as himselfe had made,
but such an one as he could wish were made;
that so it might be every way absolute. And
indeed within this age of ours, the magnificent
and Illustrious *Tycho Brabe*, who is now de-
servedly celebrated with the title of a *Second*
Atlas, hath made a very faire Cœlestiall *Globe*
composed all of wood within, and covered
over with plates of Copper artificially
wrought, containing sixe foot in Diameter,
besides the Meridian, and Horizon, and other
appendances which may be guessed at by the
rest. The like whereof, so coldly and elaborately
framed and every way exactly answering it
selfe, I thinke was never made by any. And in-
deed it is a vast and magnificent peece of
worke: insomuch that many strangers came
out of diverse parts into *Denmarke*, while it
was there, only to see this *Globe*. But *Tycho*
afterward betaking himselfe to the Emperours
Court, caried this *Globe* with some certaine
other Mathematicall instruments with him.
All which after the death of *Tycho*, were
bought for a great sum of money by the Em-
perour, and are now preserved at *Prage* in the
Imperiall Castle, and shewed among other
rarities there. About the Horizon are read
these words, written in letters of gold.

)(

Amo.

The Preface.

Anno a Christo nato CIO. ID. XXCIV.
Regnante in Dania Friderico secundo, hunc
Cælesti machina conformem Globum, in quo af-
fixa octava Sphæra sidera calius organis depi-
hensa, suis quaque locis ad amissim representari
Errantiumque stellarum per hac apparentias per-
pervestigare decrevit, cælo terrigenis, qui rari-
nem eam capiunt, Mechanico opere patefactum
TYCHO BRAHE, O. F. Sibi & Posteris
F. F.

Which *Globe*, by reason of its extraordinary
magnitude, hath this prærogative above all
other, that all things may be done upon it more
exactly, and in the very minute, especially as
farre as concerns the doctrine of the *Fixed*
moveable, together with the observations of
the *Starres*, and their aspects in respect of the
Eclipticke and *Æquator*: all which may be
done mechanically, without any tedious com-
putations.

The great *Duke of Tuscany* hath also two
very faire *Globes*, as large as this, but made
after the ordinary manner; the one a *Terre-
striall Globe*: but the other an *Armillary*
Sphere, consisting of *Circles* and *Orbes* only.

Now concerning those *Globes* of *Mercator*
spoken of by our *Author*, the same have been
since accurately corrected, according to *Tychonis*
observations; and set forth both in a greater, and
lesser forme by *I. Hondius*, and are still made
and sold by his Sonne.

And because that in this ensuing discourse
of *Globes*, there is often mention made of a *Point*
Line

The Preface.

Line, Superficies, Angle, Rhombus, Axis, and other the like Geometricall tearmes: I have thought good to set downe the severall definitions of the same.

A Point, is that which hath no parts: or nothing supposed to be Indivisible, or that cannot be divided into parts.

A Line, is a supposed length without breadth: whose extreames or bounds are two Points.

A Right Line, is the Shortest of all Lines betwixt any two the same Points.

Parallels, are Lines equidistant from each other: which though they should be proterended infinitely, would never meet in one point, but keepe still the same distance mutually.

A Perpendicular, is a Right line, falling directly on a Right line, and making on each side that point where they touch, two equall Right Angles.

A Superficies, is a Longitude, having onely Latitude: whose tearmes and limits are two Lines.

A Figure, is that which is comprehended within one, or many bounds: under one bound is comprehended a Circle: and all other Figures under many.

A Tearme or Limit, is that which is the end of any thing.

A Circle, is a Plaine Figure, comprehended under one round line: in the midst whercof there is a Point, from whence all Lines drawne to the Circumference are equall.

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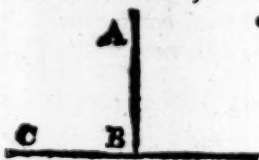
The Center of a Circle, is that Point in the midst, from which all equall lines are drawne to the Circumference.

The Diameter of a Circle, is a Right line passing through the Center, terminated at each end with the Circumference, and dividing the Circle into two equall Parts.

A Semicircle is the halfe of a Circle, contained within the Diameter and halfe the Circumference.

An Arch, is a Portion of a Circle, comprehended within a Right line, and any part of the Circumference, and is alwayes either greater or lesse then a Semicircle.

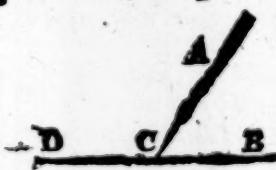
An Angle is, when two lines are extended upon the same superficies, so that they touch one another in a Point, but not directly.



A Right Angle, is that which is produced of a Right line falling upon a Right line, and making two equall Angles, on each side the

point where they touch each other : As the lines A, B, C.

An Obtuse Angle, is that which is Greater then a Right Angle : as the Angle A, C, D.



An Acute Angle, is that which is lesse then a Right : as the Angle A, C, B.

A Solid Angle, is that which is comprehended under

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under more then two plaine Angles, which are not in the same superficies, and meeting all in one point : as are the Angles of a Cube, or Die.

Rhombus, is a Figure Quadrangular, having equall sides, but not equall Angles.

Rhomboides, is a Figure having neither equall sides, nor equall Angles : yet the Opposite sides and Angles are equall.

A solid Body, is that which hath length, breadth, and thicknesse; as a Cube or Die : and the Limitts or extreames of it are superficies.

The Axis is that Diameter, about which the Sphere or Globe is turned.

The Poles of a Sphere, are the Extreames, or ends of the Diameter, and are terminated in the superficies of the Sphere.

A Sphere is defined by Euclide to be, when the Diameter of a semicircle remaining fixed, the Semicircle is turned about, till it returne againe to the place, whence it began to move at first.



THE





The first Part,

Of those things which are common both to the Cœlestiall, and Terrestiall GLOBE.

CHAP. I.

*What a Globe is, with the parts thereof: and
of the Circles of the Globe.*



Globe, in relation to our present purpose, we define to be an Analogicall representation either of the Heavens, or the Earth. And we call it Analogicall, not only in regard of it's forme, expressing the Sphericall figure, as well of the Heavens, as also of the Terrestriall Globe, consisting of the Earth it selfe, together with the interflowing Seas: but rather because that it representeth unto us in a just proportion and distance, each particular constellation in the Heavens, and every severall region and tract of ground in the Earth, together with certaine circles, both greater and lesser, invented by Artificers for the more ready computation of the same. The greater Circles we call those, which

C

divide

divide the whole superficies of the Globe into two equall parts, or halves : and those the lesser, which divide the same into two unequal parts.

PONT. *A Globe is also called a Sphere : only with this distinction, that a Sphere is properly such an one, as consists only of circles or little hoops of brasse, or the like matter, and is not a solid body, as is a Globe : the Latines call it Armillariu. Now these Circles whereof it is made, although we are not to conceive that there are any such real ones in the Heavens ; yet they have beene invented by Artificers, to the end that by means of the same, the doctrine of the true motions of the Cœlestiall bodies might the more easily bee apprehended. And what is said of the Equator, Zodiacus, Axes, and the other Circles, is also to be understood of the other Orbes themselves, and their Hypotheses. For as concerning the objections made long since by Rhœticus, and lately by Peter Ramus lib. 2. Schol. Math. touching the facility the ancient Egyptians had in searching out the courses of the Starres : I thinke it not amisse to let you see what the Noble Tycho's opinion is herein, and what answer hee once upon occasion gave Ramus himselfe, proposing the same unto him : as we find it related by himselfe in his booke of Astronomicall Epistles. pag. 60. And thus it is.*

Quod celeberrimus ille nostri ævi Philosophus P. Ramus, &c. Whereas that famous Philosopher of our times, Peter Ramus, was of opinion, that the Science of Astronomy might be framed by some certaine Logicall wayes of computation,

putation, with Hypotheses: this is nothing else but a meer ground-lesse conjecture. Which conceit of his, he proposed indeed to me about sixtene yeares since, when as wee were together at Aufspurge: wishing mee withall, that when as I had once reduced the course of the Starres into some exact order, by the Hypotheses now in use; I would then try what might be done without them. And that this might possibly be effected, he brought this for his reason, because that he had read, that the Egyptians had anciently a most easie and facile way and method in their Astronomy. And therefore, seeing that this way of computation by Hypotheses is very intricate and difficult; it must needs follow, that they had a more plaine and compendious way to the knowledge of the course of the Starres; and that without them. But I opposed him herein, shewing withall, that it was altogether impossible that the Celestiall Apperances should bee reduced into any certaine order or science, so as to bee understood, without the helpe of Hypotheses. And that this facility of the Egyptians was only in the Equatories of the Planets, whereby they freed themselves from all tedious supputation; whereas the easie and facile use of the Ephemerides was not as yet brought to light. But for as much as he (though otherwise a man of an excellent apprehension and wit, and a great lover of the truth) seemed not to bee so thoroughly acquainted with the hidden secrets of this intricate Science, and considered not that the course of the Heavenly bodies did not keepe a constant period at any set time: I wishter could, nor

indeed desired to get any thing of him, in this matter. He hath many Sectaries at this day, who have a strong faith of the possibility of this thing: but such they are, that neither understand the matter themselves, nor will ever be able to bring it to any effect. For seeing that all things consist in number, weight, and measure: without these there is not any thing in this visible world that can bee explained or understood. Now the office of these Hypotheses is, only to shew the measure of the apparent motion of the Heavenly bodies, by circles and other figures: which are againe resolved into numbers by Arithmeticke. Without which whosoever shall thinke to attaine to the knowledge of the motion of the Starres: hee may bee said to invoke Fortune, (as the Proverbe is :) and dreames of some strang incorporateall, and more than Seraphicall way, above the reach of humane capacity.

Besides the body of the Globe it selfe, and those things which we have said to be thereon inscribed, there is also annexed a certaine frame, with necessary instruments thereto belonging: which we shall declare in order.

The fabricke of this frame is thus. First of all there is a Base, or foot to rest upon: on which there are raised perpendicularly sixe Pillars ^b or a Columnes, of equall length and distance; upon the top of which there is fastened to a leuell, and parallel to the Base, a round plate or circle of wood, of a sufficient breadth and thickeesse, which they call the *Horizon*: because that the uppermost superficies thereof performeth the office of the true *Horizon*. For

The *Horizon*.

it is so placed, that it divideth the whole Globe into two equall parts: Whereof that which is uppermost, representeth unto us the visible Hemisphere, and the other, that which is hid from us. So likewise that Circle which divides that part of the world which wee see, from that other which we see not, is called the *Horizon*. And that point which is directly over our heads in our *Hemisphere*, and is on every side equidistant from the *Horizon*, is commonly called *Zenith*: but the *Arabians* name it *Semith*. But yet the former corrupted name hath prevailed, so that it is alwayes used among Writers generally. And that point which is opposite to it in the lower Hemisphere, the *Arabians* call *Nathir*; but it is commonly written *Nadir*. These two points are called also the *Poles* of the *Horizon*.

Furthermore, upon the superficies of the *Horizon* in a materiall Globe there are described, first, the twelve *Signes* of the *Zodiack*: and each of these is againe divided into thirty lesser portions: so that the whole *Horizon* is divided into 360. parts, which they also call degrees. And if every degree be divided into sixtie parts also, each of them is then called a *Scruple* or *Minute*: and so by the like subdivision of *Minutes* into sixtie parts, will arise *Seconds*, and of these *Thirds*, and likewise *Fourths*, and *Fifths*, &c. by the like partition still of each into sixtie parts.

PONT. In the midst among these *Signes* are there described certaine *Characters*, to denote the

particular Planet, to whose dominion each Sign doth appertaine. Next to this there is another Section, wherein are set downe the severall dayes of every weeke: after that followeth the number of the dayes of every Moneth throughout the whole yeare. Besides this number of the dayes, each of them hath in their severall orders some one of these three Letters affixed, K. N. I. signifying the Kalends, Nones, and Ides, which tearmes the Ancient Romans used in their accompts, to signify the dayes of every Moneth. For they did not reckon as we doe now, from the first day of every Moneth to the 30. or 31. of the same; but their account was according to the Kalends, Nones, and Ides. So that the first of each moneth was the Kalends; and the rest of the dayes of the same moneth were not reckoned forward, but after a retrograde manner. As for example: The last day of December, which with us is the 31. they called the second of the Kalends of January, and the 30. of the same moneth, the third of the Kalends of January: thus reckoning backward till they came to the Ides, which was the fourteenth of December, and the nineteenth of the Kalends of January. The like order they observed in the Ides and Nones also. Now what moneths have more or fewer Kalends or Nones may be found upon the Horizon, as we have said: and as may be gathered also out of these old verses.

*Majus sex Nonas, October, Iulius, & Mars:
Quatuor at reliqui. Tenet Idus quilibet obso.
Inde dies reliquos die omnes esse Calendas.*

There is also described upon the Horizon the
Romans

Romane Calendar, and that three ſeverall wayes: to wit, the ancient way, which is ſtill in uſe with us here in *England*; and the new way, appointed by Pope *Gregory 13.* wherein the Equinoxes and Solſtices were reſtored to the ſame places, wherein they were at the time of the celebration of the Councell of *Nice*: and in the third, the ſaid Equinoctiall and Solſticiall points are reſtored to the places that they were in at the time of our Saviour *Chriſts* nativity. The moneths in the Calendar are divided into dayes and weekes: to which are annexed, as their peculiar characters, the ſeven firſt letters of the Latine Alphabet. Which manner of deſigning the dayes of the moneth, was firſt brought in by *Dionysius Exiguus*, a *Romane* Abbot, after the Councell of *Nice*.

The innermoſt border of the Horizon is divided into 32. parts, according to the number of the windes, which are obſerved by our moderne Sea-faring men in their Navigations; by which alſo they are wont to deſigne forth the quarters of the Heavens, and the coaſts of Countries. For the Ancients obſerved but foure winds onely: to which were after added foure more: but after ages, not content with this number, increaſed it to twelve, and at length they brought it to twenty foure, as *Vitruvius* notes. And now theſe later times have made them up thirty two, the names whereof, both in *Engliſh* and Latine are ſet downe in the Horizon of Materiall Globes.

PONT. The true Horizon is either Rationall or Sensible. The Rationall or Intelligible Horizon divideth the Sphere into two equall parts exactly; and these are called the upper and the lower Hemispheres. The sensible or apparent Horizon, is so called because it onely seemes to divide the Heavens into two equall parts or Hemispheres: whereas indeed it doth not divide it so exactly, but onely seemeth so to doe. The Rationall Horizon, is also called the Artificiall, because that it was brought in for the use of Astronomy.

The use of the Horizon is manifold. First, it divides the Heavens into two Hemispheres. Secondly, it sheweth what Starres never set, and what never rise from under the earth; and so likewise what Starres doe both rise and set. Thirdly, it shewes the cause of the equality and inequality of the artificiall dayes and nights. Fourthly, it conduceth to the finding out of the latitude of any place. Fifthly, it is the cause of the Rectitude and obliquity of the Sphere; whereof we have occasion to speake more largely hereafter.

There is also let into this Horizon, two notches opposite one to the other, a circle of brasse, making right angles with the said Horizon, and placed so that it may be moved at pleasure up and downe, by those notches, as neede shall require. This circle is called the Meridian, because that one side of it, which is in like manner divided into 360. degrees, supplyeth the office of the true Meridian. Now the Meridian is one of the greater circles, passing through the Poles of the world, and also

The Meri-
dian.

of the Horizon ; to which when the Sunne in his daily revolution is arrived in the upper Hemisphere, it is midday ; and when it toucheth the same in the lower Hemisphere, it is midnight, at that place whose *Meridian* it is.

These two circles, the *Horizon* and *Meridian*, are various and mutable in the Heavens and Earth, according as the place is changed. But in the materiall Globe they are made fixed and constant : and the Earth is made moveable : that so the *Meridian* may be applied to the verticall poynt of any place.

PONT. The uses of the *Meridian* are these especially. First, It determineth the poyn^t of midday, and midnight : whence the Astronomers begin the day alwayes from this circle. Secondly, In the *Meridian* is observed the Zenith or verticall poyn^t of places, whence afterward the distances of Starres and Parallel circles are gathered. Thirdly, The Longitude and Latitude of places are taken from hence. Fourthly, It shewes the greatest elevation of the Sunne, and other Starres : which elevation is called their *Meridian Altitude*. Fifthly, By the Meridionall elevation of the Sunne, when he is in the *Equinoctiall* point, may bee found out the elevation of the Pole, and habitude or position of the Sphere. For a quarter of a circle being 90. degrees, if then we substra^{ct} the Meridionall Altitude of the Sunne in the *Equinoctiall* from 90. degrees, the remainder sheweth the elevation of the Pole. As for example, The elevation of the Sunne at noone when it is in the

the *Aequinoxe*, is about 38. degrees With us here as London : Which being deducted out of 90. there remaines 52. Which is their elevation of the Pole With us. So at Rome the *Aequinoctiall* altitude of the Sunne is about 48. degrees ; Which being substracted from 90. degrees, which is a *Quadrant*, there remaines 42. for their elevation of the Pole.

The Poles
and Axis.

In two opposite poynts, of this *Meridian*, are fastened the two ends of an iron pinne, passing thorough the body of the *Globe* and its Center. One of which ends is called the *Arcticke*, or North Pole of the world ; and the other the *Antarcticke*, or South Pole : and the pinne it selfe is called the *Axis*. For the *Axis* of the world is the *Diameter* about which it is turned. And the extreame ends of the *Axis*, are called the *Poles*.

The Hour-
circle.

To either of these *Poles*, when need shall require, there is a certaine brasse circle or ring, of a reasonable strong making, to be fastened, which circle is divided into 24. equall parts, according to the number of the houres of the day and night : and it is therefore called the *Hour-circle*. And this circle is to be applied to either of the *Poles* in such sort, as that the Section where it is described, may precisely agree with the points of mid-day and mid-night in the superficies of the true *Meridian*.

There is also another little pinne or stile to be fastened to the end of the *Axis*, in the very center of the *Hour-circle* : and this pinne is called in Latin, *Index Horarius*; and is so made, as that it turnes about and pointeth to every
of

of the 24. sections in the *Houre-circle*, according as the Globe it selfe is moved about : so that you may place the point of it to what houre you please.

PONT. *The use of this Houre-circle and Index is to denote the houres of the rising and setting of the Sunne and other Starres : which must be practised after this manner. First, you must set the Globe to your elevation or Pole, and then apply the degree of the signe, in which the Sunne at that time is, to the Meridian, and the Index to that twelfth houre which is uppermost. And so having thus done, you must turne the Globe about, till the degree wherein the Sunne is, come to the Easterne side of the Horizon ; which done, the Index will point out the houre of his rising : and if you turne it about to the West side, you shall in like manner have the houre of his setting.*

There is also belonging to the Meridian a *Quadrant of Altitude*, being made of a long thin plate of Steele or brasse, and fashioned crooked, so that it may be applied to the convexe Superficies of the Globe, and having the fourth part of the circle in length. And this Quadrant is made in such sort, as that it may be fastened on the Meridian, and so be applyed to the Zenith of any place whatsoever, being divided from one end to the other into 90. equall parts or degrees.

The Quadrant of Altitude.

There is besides at the foote of the Globe, a *Mariners compasse* placod: which serves to shew, how to place the Globe rightly, according to the foure winds or quarters of the world.

CHAP. II.

Of the Circles which are described upon the Superficies of the Globe.

The Equator.

A day Natural and Artificiall.

Houres equal and unequal.

And now in the next place we will shew what Circles are described upon the Globe it selfe. And first of all, there is drawne a circle in an equall distance from both the Poles, that is 90. degrees, which is called the *Equinoctiall*, or *Equator*; because that when the Sunne is in this Circle, dayes and nights are of equall length in all places. By the revolution of this Circle is defined a Naturall day, which the Greekes call *πυρρίμμερον*. For a day is twofold; *Naturall* and *Artificiall*. A *Naturall* day is defined to be the space of time, wherein the whole *Equator* makes a full revolution; and this is done in 24. houres. An *Artificiall* day is the space, wherein the Sunne is passing thorough our upper Hemisphere: to which is opposed the *Artificiall* night, while the Sunne is carried about in the lower Hemisphere. So that an Artificiall day and night are comprehended within a Naturall day.

The Parts of a day are called houres; which are either *Equall* or *Vnequall*. An *Equall* houre is the 24. part of a *Naturall* day, in which space, 15. degrees of the *Equator* doe alwayes rise, and as many are depressed on the opposite part. An *Vnequall* houre is the 12. part of an

an Artificiall day, betwixt the time of the Suns riſing and ſetting againe. Theſe houres are againe divided into Minutes. Now a Minute is the 60. part of an houre: in which ſpace of time, a quarter of a degree in the *Æquator*, that is, 15. minutes doe riſe, and as many ſet.

PONT. *The uſe of the Æquator conſiſts chiefly in theſe things. Firſt, it ſheweth the time of the Æquinoxes, which are alwayes when the Sunne falls upon the Æquinoctiall circle. And this is, when as the Sunne enters into the firſt degree of Aries and Libra: according to that of Manilius.*

Libra Ariéſq; parem reddunt noctemq; diemq;
In Engliſh thus.

*The Sunne in Libra' and Aries plac'd, each yeare:
The day and night are equall every where.*

Secondly, the Æquator divides the Heavens into two equall parts, or Hemifpheres, whereof one is called the Septentrionall or Northerne Hemifphere: the other, the Meridionall or Southerne. Thirdly, it ſheweth the aſcenſion and deſcenſion of the parts of the Zodiacke: whence the length of the Artificiall day and night, for any poſition of Sphere, may be knowne. Fourthly, it ſheweth what Starres, and parts of the Eclipticke have any Declination.

The *Æquator* is croſſed or cut in two oppoſite points, by an oblique Circle, which is called the *Zodiacke*. The obliquity of this Circle is ſaid to have beene firſt obſerved by *Anaximander Mileſius*, in the 58. Olympiad. as *Pliny* writeth in his *lib. 2. Cap. 8.* who alſo in the ſame

same place affirms, that it was first divided into 12. parts, which they call *Signes*, by *Cleostratus Tenedius*, in like manner as we see it at this day. Each of these *Signes* is again subdivided into 30. parts: so that the whole *Zodiacke* is divided in all into 360. parts, like as the other circles are. The first twelfth part whereof, beginning at the Vernal Interfection, where the *Aequator* and *Zodiacke* cross each other, is assigned to *Aries*, the second to *Taurus*, &c. reckoning from West to East. But here a young beginner in Astronomy may justly doubt, what is the reason, that the first 30. degrees, or 12. part of the *Zodiacke* is attributed to *Aries*, whereas the first Starre of *Aries* falls short of the Interfection of the *Aequinoctiall* and *Zodiacke* no lesse then 27. degrees. The reason of this is, because that in the time of the Ancient *Greekes*, who first of all observed the places and situation of the fixed Starres, and expressed the same by *Asterismes* and *Constellations*, the first Starre of *Aries* was then a very small space distant from the very Interfection. For in *Thales Miletius* his time, it was two degrees before the Interfection: in the time of *Meton the Athenian* it was in the very Interfection: in *Timocharis* his time it came two degrees after the Interfection. And so by reason of it's vicinity, the Ancients assigned the first part of the *Zodiacke* to *Aries*, the second to *Taurus*, and so the rest in their order.: as it is observed by succeeding ages, even to this very day.

PONT. Thales Milesius was the first that calculated the time of the Equinoxe, and Eclipses: and he flourished about the yeare of the Creation, 3370. which was about 634. yeares before Christ. Meton lived about 431. yeares before Christ, in the yeare of the Creation, 3517. He was the Sonne of Pausanias, and was a man of excellent knowledge in Astronomy. He also first invented the Moones Circle of 19. yeares: whose first new Moone fell upon the 13. day of the moneth Scirophorion, which is the same with our 26. of June, being on a Friday. Vid. Diodorum Siculum. Censorinus writes of him thus, Præterea sunt &c. There are (saith he) besides, many other great yeares: as the Metonically yeare, which Meton the Athenian invented, and consisted of 19. common yeares, &c. Timochares was by nation an Alexandrian, and he lived 300. yeares before Christ.

Vnder this circle, the Sunne and the rest of the Planets finish their severall courses and periods, in their severall manner and time. The Sunne keepe his course in the middest of the Zodiacque, and therewith describeth the Eclipticke circle. But the rest have all of them their latitude and deviations from the Suns course, or Eclipticke. By reason of which their digressions and extravagancies, the Ancients assigned the Zodiacque 12. degrees of latitude. But our moderne Astronomers, by reason of the Evagations of Mars, and Venus, have added on each side two degrees more: so that the whold latitude of the Zodiacque is confined within

within 16. degrees. But the *Eclipticke* onely is described on the *Globe*, and is divided, in like manner as the other circles, into 360. degrees.

PONT. The whole latitude of the *Zodiacke* is divided into two parts by the *Eclipticke*, which is the circle or circumference, under which the Sun steeres his course continually. Whence it is called in *Latine*, *Via Solis*, & *Orbita Solis*, the *Sunnes high way*. And in *Greeke*, *ὡκεανὸς διὰ μέσων τῶν ζῳδίων*, a Circle dividing the *Zodiacke* in the midst. And it is called the *Eclipticke*, because the *Eclipses* of the *Sunne* and *Moone* never happen, but when they are either in conjunction or opposition under this line, or very neare the same.

The *Sunne* runneth thorough this Circle in his yearly motion, finishing every day in the yeare almost a degree by his Meane motion, that is 59. minutes, 8. seconds. And in this space he twice crosseth the *Aequator*; in two poynts equally distant from each other. So that when he passeth over the *Aequator* at the beginnings of *Aries* and *Libra*, the dayes and nights are then of equall lengeh. And so likewise when the *Sunne* is now at the farthest distance from the *Aequator*, and is gotten to the beginning of *Cancer*, or *Capricorne*, he then causeth the *Winter* and *Summer Solstices*. I am not ignorant, that *Virruvius*, *Pliny*, *Theon Alexandrinus*, *Censorinus*, and *Columella* are of another opinion; (but they are upon another ground,) when as they say, that the *Aequinoxes*

Equinoxes are, when as the Sunne passeth through the eighth degree of *Aries* and *Libra*, and then it was the midst of Summer and winter, when the Sun entred into the same decree of *Cancer* and *Capricorne*. But all these Authors defined the Solstices by the returning of the shadow of dials: which shadow cannot be perceived to returne backe againe, as *Theon* saith, till the Sunne is entred into the eighth degree of *Libra* and *Aries*.

PONT. The office and use of the *Zodiaque* is. First, in that it is a rule or measure of the proper motion of the Planets. Secondly, By the helpe of the *Zodiaque* the true places of all the Starres are found: besides it may be knowne in what signe any fixed Starre or Planet may be said to be. Thirdly, It sheweth the latitude of the Planets and fixed Starres. Fourthly, All Eclipses happen when the Sunne and Moone are under the *Ecliptique*. Fifthly, The obliquity of the *Ecliptique* is the cause of the inequality of the artificiall dayes and nights.

The space wherein the Sunne is finishing his course through the *Zodiaque*, is defined to be a *Yeare*, which consists of 365. dayes; and almost 6. houres. But they that thinke to find the exact measure of this period, will find themselves frustrate: for it is finished in an un-equall time. It hath beene alwayes a controverse very much agitated among the Ancient *Astronomers*, and not yet determined. *Philolaus* a *Pythagorean* determines it to be 365. dayes: but all the rest have added something more

more to this number. *Harpalus* would have it to be 365. dayes and a halfe : *Democritus* 365. dayes and a quarter, adding beside the 164. part of a day. *Oenopides* would have it to be 365. dayes, and almost 9. houres. *Meton* the *Athenian* determineth it to be 365. dayes, 6. houres, and almost 19. minutes. After him *Calippus* reduced it to 365. dayes and 6. houres, which account of his was followed by *Aristarchus* of *Samos*, and *Archimedes* of *Syracusa*. And according to this determination of theirs, *Julius Caesar* defined the measure of his Civile year, having first consulted (as the report goes) with one *Sofigines* a *Peripateticke*, and a great Mathematician. But all these, except *Philolaus*, (who came short of the just measure) assigned too much to the quantity of a year. For that it is somewhat lesse then 365. dayes, 6. houres, is a truth, confirmed by the most accurate observations of all times, and the skiltullest Artists in Astronomicall affaires. But how much this space exceedeth the just quantity of a year, is not so easie a matter to determine. *Hipparchus*, and after him *Ptolomy*, would have the 300. part of a day subtracted from this measure : (for *Jacobus Christmannus* was mistaken, when he affirmed, that a Tropicall year, according to the opinions of *Hipparchus* and *Ptolomy*, did consist of 365. dayes, and the 300. part of a day) For they doe not say so, but that the just quantity of a year is 365. dayes, and 6. houres, abating the 300. part of a day : as may be plainly gathered out

of

of *Ptolomy*, *Almagest. lib, 3. cap. 2.* and as *Christmannus* himselfe hath elsewhere rightly observed. Now *Ptolomy* would have this to be the just quantity of a yeare perpetually and immutably: neither would he be perswaded to the contrary, notwithstanding the observations of *Hipparchus*, concerning the inequality of the Sunnes periodiacall revolution. But yet the observations of succeeding times, compared with those of *Hipparchus* and *Ptolomy*, doe evince the contrary. The *Indians* and *Jewes* subtract the 120. part of a day: *Albatagnus* the 600. part: the *Persians* the 115. part: according to whose account *Messabalah* and *Albumasar* wrot their tables of the Meane motion of the Sunne. *Azaphius*, *Avarinus* and *Arzachel* affirmed that the quantity assigned was too much, by the 136. part of a day. *Alphonsus* abateth the 122 part of a day: some others, the 128. and some the 130. part of a day. Those that were lately imployed in the restitution of the Romane Calendar, would have almost the 133. part of a day to be subtracted, which they conceived in 400. yeares, would come to three whole dayes. But *Copernicus* observed that this quantity fell short, by the 115. part of a day. Most true therefore was that conclusion of *Censorinus*, that a yeare consisted of 365. dayes, and I know not what certaine portion, not yet discovered by *Astrologers*.

By these divers opinions here alleadged is manifestly discovered the error of *Dion*, which

is indeed a very ridiculous one. For he had a conceit that in the space of 1461. *Julian* yeares, there would be wanting a whole day for the just measure of a yeare; which he would have to be intercaled, and so the *Civile Julian* yeare would accurately agree with the revolution of the Sunne. And *Galen* also, the Prince of Physitians, was grossely deceived, when he thought that the yeare consisted of 365. dayes, 6. houres, and besides almost the 100. part of a day: so that at every hundred yeares end there must be a new intercalation of a whole day.

The mutation of the Equinox, and Solstices.

Now because the *Julian* yeare, (which was instituted by *Julius Caesar*, and afterward received, and is still in use) was somewhat longer then it ought to have beene: hence it is that the *Equinoxes* and *Solstices* have gotten before their ancient situation in the Calendar. For about 432. yeares before the incarnation of our Saviour *Christ*, the Vernal *Equinox* was observed by *Meton* and *Euctemon*, to fall on the 8. of the Kalends of *Aprill*, which is the 25. of *March*, according to the computation of the *Julian* yeare. In the yeare 146. before *Christ* it appears by the observations of *Hipparchus*, that it is to be placed on the 24. of the same moneth, that is the 9. of the Kalends of *Aprill*. So that from hence we may observe the error of *Sosigenes* (notwithstanding he was a great Mathematician) in that above 100. yeares after *Hipparchus*, in instituting the *Julian* Calendar, he assigned the *Equinox*

quinox to be on the 25. of *March*, or the 8. of the Kalends of *Aprill*, which is the place it ought to have had almost 400. yeares before his time, This error of *Sosigenes* was derived to succeeding ages also: in so much that in *Galens* time, which was almost 200. yeares after *Julius Cesar*, the Equinoxes were wont to be placed on the 24. day of *March* and *September*: as *Theodorus Gaza* reports, In the yeare of our Saviours Incarnation, it happened on the 10. of the Kalends of *Aprill*, or the 23. of *March*. And 140. yeares after, *Ptolomy* observed it to fall on the 11. of the Kalends. And in the time of the Councell of *Nice*, about the yeare of our Lord 328. it was found to be on the 21. of *March*, or the 12. of the Kalends of *Aprill*. In the yeare 831. *Thebis Ben. Chorah* observed the Vernall Equinox to fall on the 17. day of *March*: in *Alfraganus* his time it came to the 16. of *March*. *Arzachel a Spaniard* in the yeare 1090. observed to fall on the Ides of *March*, that is the 15. day. In the yeare 1316. it was observed to be on the 13. day of *March*. And in our times it is come to the 11. and 10. of the same moneth. So that in the space of 1020. yeares, or thereabout, the Equinoctiall points are gotten forward no lesse then 14. dayes. The time of the Solstice also about 388. yeares before *Christ*, was observed by *Meton* and *Euctemon* to fall upon the 28. day of *Iune*: as *Joseph Scaliger*, and *Jacobus Christmannus* haue observed. But the same in our time is found to be on the 12. of the same moneth.

The Co-
lures.

The Eclipticke and Equator are crossed by two great Circles also, which are called *Colures*: both which are drawne thorough the Poles of the world, and cut the Equator at right Angles. The one of them passing thorough the points of both the Intersections; and is called the *Equinoctiall Colure*: The other passing through the points of the greatest distance of the Zodiacke from the Equator, is therefore called the *Solsticiall Colure*.

PONT. The office of the Colures in generall is. First to shew the foure principall points of the Zodiacke, in which, by reason of the motion of the Sunne, there are caused the great changes of the Seasons of the yeare. Of which points, two are in the Equator, at Aries and Libra, determining the place of the Equinoctiall Colure: and the other two are in the Tropickes at Cancer and Capricorne, which constitute the Solsticiall Colure. Secondly, To distinguish the Equator, Zodiacke, and the whole Sphere of the Heavens into foure equall parts. The use of which is principally seene in examining the ascensions of the Signes. These Colures differ from each other, in that the Solsticiall Colure passeth through the Poles of the world, and also of the Zodiacke: but the Equinoctiall Colure passeth through the Poles of the world only.

Now that both the Colures, as also the Equinoctiall points have left the places, where they were anciently found to be in the Heavens, is a matter agreed upon, by all those that have applyed themselves to the observations

tions of the Ccelestiall motions : onely the doubt is, whether fixed Starres have gone forward unto the preceding Signes, as *Ptolomy* would have it : or else whether the *Equinoctiall* and *Solsticiall* points have gone backward to the subsequent Signes, according to the *Series* of the *Zodiacke*, as *Copernicus* opinion is.

PONT. *What the opinion of Ioseph Scaliger was, concerning the proceſſion of the Equinoctiall points, thus diverſly thought on by Ptolomy and Copernicus, you have expreſſed in an Epistle of his to Iſaac Caſaubon, there having beene not long before a diſputation holden concerning ſome certaine Mathematicall queſtion, at the entreaty of ſome of the chiefeſt of the States in the Low-Countries ; among which number Scaliger was choſen alſo, as an Arbitrator : which Epistle of his, was afterward printed among ſome other of his Epistles at Paris. What the Illuſtrious Tycho alſo thought concerning this point, you have in his Progymnaſmata Inſtaur. Aſtron. p. 255. But I will firſt ſet downe Scaliger's opinion : and afterward adde Tychoe's, and ſome others alſo. Scaliger ſpeaketh thus.*

Alteræ literæ tuæ, &c. I received (ſaith he) your ſecond letters the next day after your former. In which you make mention of one that undertakes to diſcourſe of the Magneticall direction of the Needle. Many indeed have endeavoured in this matter, and doe dayly endeavour, being thereto encouraged by the rewards propoſed by the Illuſtrious States. To whoſe hands ſome have delivered

livered up their opinions in writing : and Arbitrators forthwith have beene called about it. Of which number it was my chance to be chosen for one : there being indeed amongst them many excellent, both Mathematicians and Mariners. But those that professed the Mathematickes, were altogether unexperienced in Nauticall affaires: and the Navigators were as ignorant of Astronomieall. Besides, those Authors of whom we were to passe our judgements, performed nothing worth so great expectation. Neither hath that Englishman, who wrote a Booke three yeares since, of the Magnet, produced any thing answerable to the great opinion was raised of it. I my selfe have often proposed to these Mathematicians that professe in this place, a thing which it seemes can never sinke into their heads : in so much that they entertained it with scorne and laughter. Hipparchus was the first that brought in that merry conceit of the eight Spheres moving toward the East : and so perswaded Ptolomy, that the fixed Starres in the eight Sphere moved all in the same order, situation, and distance from each other, toward the East. Which Ptolomy so confirmed, that it had beene a heinous matter for posterity to have doubted of the same. And first of all within the memory of our Fathers, Nicolaus Copernicus, that great restorer of Astronomy, perceived the weakenesse of this conceit of Hipparchus : and with all observed, that the eight Sphere did not move toward the East, but that the Equinoctial points went forward into the precedent Signes: and this he calls *de revolutionibus*

But

But this obſervation of his, hee onely nakedly propoſed, without any demonſtration at all. But I have obſerved, that the Starres have not (as Hipparchus and Ptolomy dreame) gone on to the ſubſequent parts: and that the Cynofure, or Polar Starre, was at the ſame diſtance from the Pole in Eudoxus his time, as it is at this day. For prooſe of which aſſertion I have collected many inſtances: which being granted, the preceſſion of the Equinoctiall points muſt neceſſarily follow. For one of theſe two muſt needs be granted; to wit, either the motion of the eighth Sphere toward the Eaſt, or elſe the progreſſe of the Equinoctiall points into the precedent Signes. Now that the firſt is not to be admitted appears manifeſtly, becauſe that the fixed Starres have not at all changed their ſituation in reſpect of the Pole, ſince Eudoxus his time. Therefore the other muſt needs be granted. The Equinoctiall points therefore have gone forward to the antecedent Signes. Which propoſition notwithstanding the great Copernicus had no way to demonſtrate, but out of the Phenomena; by which that other motion might as well be defended, as this. Wee therefore now have this *ωεζήνως ιοναυεν*. But what is it? Even nothing elſe, but the motion of the Equinoctiall points into the precedent Signes. Now if the Equinoctiall points be moveable; and the Equinoctiall Circle be deſcribed by theſe points; the Equinoctiall Circle then muſt needs be moveable alſo: which is as true, as truth it ſelfe. And if the Equinoctiall circle be moveable; his Poles muſt be moveable alſo: and ſo

So the Poles of the Equinoctiall must be divers from the Poles of the world. For the Pole of the world is immoveable; but this moveable. Besides, all the Meridian circles doe passe through the Poles of the Equinoctiall: and in the superficies of stone Dials, the Meridian line, which is drawne for the placing of the Sunne Diall, is understood to passe through the Poles of the Equinoctiall; which is confest by all men, and is most true. But because the Poles of the Equinoctiall are moveable, the Meridian lines, that passe through the same, must be moveable also. And therefore it necessarily followeth, that after some certaine number of yeares, there will be no further use of these Meridian lines in the designing of the houres in Dials; but a new Meridian line must be taken, and the situation of the Diall altered, though not the Diall it selfe. We may therefore conclude, that the Sunne Dials, after some certaine time, will prove false, unlesse the Meridian line be rectified. This is demonstrated out of the very principles of the Mathematickes. But besides this, we have some notable instances out of the Ancients, which doe manifestly evince, that after some terme of yeares, Sunne Dials doe not agree to their first designations: all which I have diligently collected. These things thus demonstrated, I proposed them to these Mathematicians, that, because the whole businesse of the Magneticall Needle had dependance upon these Meridians; they would consider whether or no this doctrine, by me first proposed, might open the way to the matter in hand, &c.

Thus

Thus farre Scaliger. Let us now heare Tycho. Inæqualitatis, inquit, circa motum, &c. That the reason (saith he) of the inequality observed in the motion of the fixed Starres, or as Copernicus calls it, the Anticipation of the Equinoxiall points (which is a very subtile and ingenious Speculation of his owne, that so he might reconcile and maintaine the inventions of all that went before him) that this conceit, I say, doth not constare sibi, these 70. yeares observations of the Starre called Spica Virginis, since his first observing the same, doe manifestly prove. For in this space of time, the reciprocation of the Equinoctiall points, or promotion of the Starres, is swifter by much then he conceived it would have bene. So that whereas now they ought to have finished but one degree in an hundred yeares space, or thereabout, they finish the same in 70. the quantity of the yeare being not so slow as he imagined it to be: as appears plainly by that we have delivered in the former Chapter. For these two things doe mutually cohere together in Copernicus, that when the quantity of the yeare is greatest, the motion of the fixed Starres should then be slowest. But these things the accurate observations of these present yeares doe manifestly elude, for as much as they doe not answer his periodiacall restitutions.

Thus these two great lights of our times, Tycho, and Scaliger, to whom we may add the opinion of our Countryman Dr. Gilbert, who in his 6th booke de Magnete, will have the procession of the Equinoctiall points to depend upon the
Magneticall

Magneticall motion of the Poles of the Earth. And this is that English-man, as farre as I can gather, whom Scaliger mentions in his fore-cited Epistle. Vnto whom I referre you for satisfaction in this point, in his lib. 6. cap. 8.

The first Starre of *Aries*, which in the time of *Meton the Athenian*, was in the very Vernall Interfection, in the time of *Thales Milesius* was two degrees before the Interfection. The same in *Timochares* his time, was behind it two degrees, 24. minutes : in *Hipparchus* time, 4. degrees, 40. minutes : in *Albunassar* time, 17. degrees, 50. minutes : in *Albarenu* his time, 18. degrees, 10. minutes ; in *Arzachels* time, 19. gr. 37. minutes ; in *Alphonfus* his time, 23. degrees, 48. minutes : in *Copernicus* and *Rheticus* his time 27. degrees, 21. minutes. Whence *Franciscus Barocius* is convinced of manifest error, in that he affirms that the first Starre of *Aries*, at the time of our Saviours Nativity, was in the very Vernall interfection : especially contending to prove it, as he doth, out of *Ptolomies* observations, out of which it plainly appeares, that it was behinde it no lesse then 5. degrees.

In like manner the places of the Solstices are also changed, as being alwayes equally distant from the *Æquinoctiall* points. This motion is finished upon the Poles of the *Eclipticke*, as is agreed upon both by *Hipparchus* and *Ptolomy*, and all the rest that have come after them. Which is the reason that the

the fixed Starres have alwayes kept the same latitude, though they have changed their declination. For confirmation whereof many testimonies may be brought out of *Ptolomy*, lib. 7. cap. 3 *Almag.* I will onely alleadge one more notable then the rest, out of *Ptolomies* Geogr. lib. 1. cap. 7. The Starre which we call the *Polar Starre*, and is the last in the taile of the Beare, is certainly knowne in our time to be scarce three degrees distant from the Pole: which very Starre, in *Hipparchus* his time, was above 12. degrees distant from the Pole: as *Marinus* in *Ptolomy* affirmes. I will produce the whole passage, which is thus. *In the Torrid Zone, (saith he) the whole Zodiacke passeth over it, and therefore the shadowes are cast both wayes, and all Starres there are seene to rise and set. Onely the little Beare begins to appeare above the Horizon in those places, that are 500. furlongs Northward from Ocele. For the Parallel that passeth through Ocele is distant from the Equator 11. gra. $\frac{2}{3}$. And Hipparchus affirmes, that the Starre in the end of the little Beares taile, which is the most Southward of that Constellation, is distant from the Pole 12. gr. $\frac{2}{3}$. This excellent testimony of his the Interpreters have in their translating the place, most strangely corrupted (as both Johannes Wernerus, and after him P. Norius have observed) setting downe in stead of 500. *Quinque mille*, 5000. and for *Australissimam*, the most Southerne, *Borealisimam*, the most Northerly:*

ly : being led into this error perhaps, because that this Starre, is indeed in our time the most Northerne. But if these testimonies of *Marinus* and *Ptolomy* in this point be suspected, *Strabo* in his *lib. 2. Geogr.* shall acquit them of this crime. And he writes thus. It is affirmed by *Hipparchus* (saith he) that those that inhabit under the Parallel that runneth thorough the Countrey called *Cinnamomifera* (which is distant from *Meroë* Southward, 3000. furlongs. and from the *Æquinoctiall*, 8800.) are situated almost in the midst, betwixt the *Æquator* and the Summer Tropicke, which passeth through *Syene* (which is distant from *Meroë* 5000. furlongs) And these that dwell here, are the first that have the Constellation of the little Beare inclosed within their Arcticke Circle, so that it never sets with them : for the bright Starre, that is scene in the end of the taile (which is also the most Southward of all) is so placed in the very Circle it selfe, that it doth touch the Horizon. This is the testimony of *Strabo*, which is the very same that *Ptolomy* and *Marinus* affirme ; saving that both in this place, and elsewhere, he alwayes assigns 700. furlongs in the Earth, to a degree in the Heavens, according to the doctrine of *Eratosthenes* : whereas both *Marinus* and *Ptolomy* allow but 500. onely : of which wee shall speake more hereafter.

Let us now come to the lesser Circles
which

which are described in the Globe. And these are all Parallels to the *Æquator* : as first of all the *Tropickes*, which are Circles drawne through the points of the greatest declination of the *Eclipticke*, on each side of the *Æquator*. Of which, that which lookes toward the North Pole, is called the *Tropicke of Cancer* : and the other, bordering on the South, the *Tropicke of Capricorne*. For the Sunne in his yearely motion through the *Eclipticke*, arriveing at these points, as his utmost bounds, returneth againe toward the *Æquator*. This Retrocession is called by the *Greekes*, *Ἰστρον*, and the Parallel Circles drawne through the same points, are likewise called *Tropickes*.

PONT. The use of these *Tropickes* is, First, to shew when the Sunne in an oblique Sphere, is neereſt the verticall point of any place, and so likewise when he farthest off. Secondly, they shew, when the Sunne in his Diurnall motion maketh the longest or shortest dayes in the yeare. Thirdly, they are, as it were, the limits and bounds, wherein the Sunne finisheth his yearely course. Fourthly, they distinguish the *Torrid Zone* in the Heavens, from the two temperate Zones.

The distance of the *Tropickes* from the *Æquator*, is diversly altered, as it may plainly appeare, by comparing the observations of later times, with these of the Ancients. For, not to speake any thing of *Strabo*, *Proclus*, and *Leontius Mechanicus*, who

who all assigned the distance of either Tropicke from the *Æquator* to be 24. degrees (for these seeme to have handled the matter but carelessly) we may observe the same from the more accurate observations of the greatest Artists. For *Ptolomy* found the distance of either Tropicke to be 23. gr. 51. min. and 1. just as great, as *Eratosthenes* and *Hipparchus* had found it before him : and therefore hee conceived it to be immutable. *Machometes Aratenfis* observed this distance to bee 23. degrees, 35. minutes, right as *Almamoon* King of *Arabia* had done before him. *Arzabel* the *Spaniard* found it to be in his time, 23. degrees, 34. minutes. *Almebon* the Sonne of *Albumasar*, 23. degrees, 33. minutes, and halfe a minute. *Prophatius* a Jew, 23. degrees, 32. minutes, *Purbachius* and *Regiomontanus*, 25. degrees, 28. minutes. *Joban Wernerus*, 23. degrees, 18. minutes and an halfe : and *Copernicus* found it in his time to be just as much.

PONT. This distance of the Tropickes from the *Æquator*, is caused by the Sunnes greatest declination, as the Astronomers call it. Which greatest declination of the Sunne hath bene at divers times found to be variable. For beginning as farre backward, as possibly we can, and so driving it downe by the Olympiads, and the yeares of Christ, even to these present times, according to Tychoes calculation, we finde it to be thus, both in the degree and minute, as is here expressed in this ensuing Table.

Aratus

	gr. m. 11.	
Aratus	24. 0. 0.	Olympiad.
Hipparchus	{ 23. 51.	{ 134.
Eratosthenes	{	{ 137.
Ptolomæus	23. 51. 20.	An. Christi 140.
Albategnius	23. 35. 0.	749.
Arzabel	23. 34. 0.	1070.
Almeon	23. 33. 1.	1140.
Prophatius Indani	23. 32. 0.	1300.
Purbachius	23. 29. 30.	1458.
Regiomontanus	23. 30. 0.	1490.
Copernicus	23. 38. 30.	1500.
Tycho Brahe	23. 31. 1.	1592.

To which wee may adde these words out of Tychoes. i. Booke, of the new Star which appeared An. 1572. p. 101. where he saith; that by certaine observation it hath bene found; that both the Suns greatest declination, as also the other Intermediates by the same reason are altered, as is testified by the whole current of the most skilfull Astricks in a continuall succession of time: so that Ptolomæus time, and some certaine yeares before him, it was found to be 23. gr. 51. 1. but is doth not appeare by any certaine testimony to have bene ever greater. Whence may be collected, that Aratus, whom we have set in the first place, who assignes 24. gr. speaks with the largest; and as it were, as randomly; and (as our learned Author hath also observed of Strabo, Proclus, and Leontius Mechanicus) not so accurately as he should have.

There are also two other lesser circles described in an equal distance from the Poles; to that of the Tropicks from the Equator;

E

which

The Arctique, and Antartique circles.

which circles take their denomination from the Pole on which they border. So that one of them is called the *Arctique* or North circle; and the opposite circle the *Antarctique* or Southerne. In these circles the Poles of the Ecliptique are fixed, the Solstitiall Colure cutting them in the same place. *Strabo, Ptolemy, Cleomedes*, all Greeke Authors, and some of the Latines also, assigne no certaine distance to these circles from the Poles: but make them various, and mutable according to the diversity of elevation of the Pole, or diverse position of the Sphere: so that one of them must be conceived to bee described round about the Pole which is elevated, and to touch the very Horizon, and is therefore the greatest of all the Parallels that are alwayes in sight: and the other must be imagined as drawne in an equall distance from the opposite Pole; and this is the greatest of those Parallels that are alwayes hidden.

P O N T, *The Arctique and Antarctic circles doe shew, 1. The Poles of the Zodiacque and their distance from the Poles of the world. 2. They doe distinguish the frigid Zones from the Temperate, and with the Tropiques and Equator doe helpe to divide the whole Heavens into five parts or regions which they call Zones.*

Beside these circles expressed in the *Globe*, there are also some certaine other circles in familiar use with the Practicall Astronomers, which they call *Verticall circles*. These are greater circles drawne from the *Verticall point* through

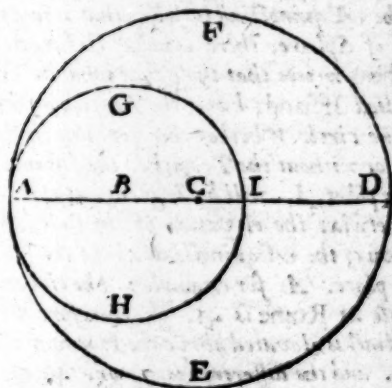
The Verticall circles.

through the Horizon, in what number you please: and they are called by the *Arabians*, *Azimuth*, which appellation is also in common use among our ordinary Astronomers. The office of these circles is supplied by the helpe of a Quadrant of Altitude, which is a thin plate of brasse, divided into 90. degrees. This Quadrant must bee applied to the vertex of any place, when you desire to use it, so that the lowest end of it, noted with the number of 90. may just touch the Horizon in every place. This Quadrant is made moveable, that so it may be fastned to the verticall point of any place.

P O N T. Concerning the moveablenesse or mutability of the Arctique and Antarctique Circles, Ioseph Scaliger reports himselfe to bee the first that observed it out of the Ancient Greeke Authors: as you may see in his Commentaries upon Manilius, revised, and published by himselfe a little before his death. Neither doth he thinke that any ancient latine Author within 400. yeares after those Greeke Writers, nor scarcely any before Sacrobosco's time, can be found to have determined them to bee immoveable. But because there are many excellent things to be met withall in that passage of his; and that he sets downe the same by way of demonstration; I have thought it not impertinent, seeing our Author hath given a touch at it, to set downe Scaliger's opinion in his owne words: as you have them upon those verses of Manilius; lib. 1. Astron. Circulus ad Boreā fulgentem sustinet Arcton; Sexque fugit solidas a cœli vertice partes.

He proceeds after this manner. Describantur circuli Equinoctiali paralleli XC &c. Let there be described (saith he) 90. Parallel circles to the Equinoctiall, and these will be the same that Geminus calles, ἀνταρπύς, alwayes appearing. Now among all these, That which toucheth the Horizon in the point of intersection of the Horizon and Meridian, will be, μίγξϛ τὸν ἀνταρπύ, the greatest of those that alwayes appears, and so consequently, the Arctique Circle of the place. Now because the Horizons are mutable, the Arctique Circles must also be moveable. So in the Climate wherein Cnidus lies, the elevation of the Pole being thirtie sixe degrees, Eudoxus determines the Arctique circle also to be so many degrees from the Pole. In like manner in another Climate, it will bee diverse, according to the diversity of the elevation of the Pole. Thus Hipparchus ὁδ' ἐν Ἀδύνας ἀνταρπύς κῶλα ϛ ἀνταρπύ ἀπὸ τοῦ πόλου πλεονεξεί μίγξϛ λζ. ὁδ' ἐν Ρόδῳ πλεονεξεί λς. At Athens (saith he) the greatest of the Circles alwayes appearing is distant from the Pole thirtie seven degrees: but that in Rhodes thirtie sixe degrees: and looke how great the Altitude of the place is, the same must the distance necessarily be betwixt the Pole and that point, by which the Arctique circle is described. And therefore the Ancient Greekes alwayes defined the Arctique circle to be, τὸ ἀρκτικώτατον σημεῖον τοῦ οὐρανῶ. ἢ τὸ ἀρκτικώτατον τῆς ἐκείνου σημεῖον. The most Northerne point that their Horizon, or place of habitation had. So that the Arctique circle is nothing else, but the point of their habitation which toucheth

eth the Horizon. For in deſcribing, they have both on common point. Only in this they differ, that the center of the Arctique circle is the Pole of the world; but the center of the Horizon is the Verticall circle, or Zenith of the place.



As for example. A. F. D. E. is the Horizon; A. G. C. H. the Arctique circle A. D. the Meridian: A. the point of Interſection of the Horizon with the Meridian; in which place alſo the Arctique and Horizon in deſcribing doe mutually touch each other. B. the Pole: C. the Zenith of the place. I. the oppoſite point of the diameter of the Arctique circle. Now if the elevation of the Pole bee full 45. degrees, as it is at Vienna in France, then the point I. will be the ſame with C. that is to ſay, the oppoſite part of the Arctique circle will touch the Zenith of the place. But if the elevation of the Pole be leſſe then 45.

E 3 degrees,

degrees, the Zenith will then fall without the circle; but if it be greater, it will fall within. So that by this meanes it will come to passe, that the nearer we are to the Equator, the lesser these circles will be: and contrariwise, the farther we lye off the Equator, the greater they are: But under the Equinoctiall it selfe, that is in a right position of Sphere, there is no Arctique circle at all: Pytheas writes, that those that inhabite Thule, now called Island, have the Tropike for their Arctique circle. Whether therefore this circle fall within, or without the Tropicke, the distance of it from the point, I. will be as great, as is the difference betwixt the elevation of the Pole, and the elevation of the Equinoctiall above the Horizon of the place. As for example: The elevation of the Pole at Rome is 41. gr. therefore the Equinoctiall is elevated above the Horizon 48. gr. 20. m. and the difference is 7. gr. 40. m. And therefore the Zenith, or verticall point of Rome, falleth 7. gr. 40. m. without the circumference of its Arcticke circle. So this distance with those that inhabite Island, is 43. gr. as having their Pole elevated 66. gr. 30. m. So that the Tropicke with them toucheth the very point of intersection of the Meridian and Horizon. And therefore Martianus Capella defines the Arcticke circle to be. *Semper apparet, & contingens confinia Finitoris, nunquam meris assurgens.* A circle that alwayes appeareth, and toucheth upon the skirts of the Horizon, yet never goeth under it. By these words *Confinia Finitoris*, he meaneth the intersection of the Horizon and Meridian.

Meridian, is vntique *apertur* in the most Northerly point.

These grounds being thus laid, we see that as many habitations as there are, so many Arcticke circles there are also, and the same not diuerse, but fixed and unchangeable, but different according to the diversity of places. So that by this we may plainly perceiue the error of our moderne Astronomers, who in their Artificiall Globes describe this circle contrary to the doctrine and practise of the Ancients, drawing it on the Poles of the Ecliptique about the Pole of the world. For such an Arcticke circle there cannot be, but only such as that inhabite Syene by the Nile: for without the Pole is elevated 23. gr. 30. m. These things considered, the Arcticke circle ought not to haue any place in the Materiall Globe, unless it be made for the inclination of some certaine place: otherwise there can be no such Arcticke circle.

These things when I first proposed in Aquitaine, where were many, both learned and unlearned, Noble and Pedants, it cannot be imagined with what scorne and hissing they entertained them. And at length when my constancy would not giue place to their stubborne ignorance, I thought I should haue beene beaten among them. For at last, having nothing to defend themselves with, they said, that, however it were, these circles were usefull for the distinction of the Zones. At which answer of theirs, I had much ado to forbear laughing. For this diuision of the world into Zones is quite castiered in these ages, when as the whole world hath at length beene fully discou-

red by the Navigations of the Portugals and Spaniards. And for this purpose, to confute these Mathematicians, I alledged those words of Strabo. ὁ Περικλῆς ἐν β', τὸ πρῶτον μὲν λέγει τοὺς ἀπὸ τῆς ἀπορίας ἀποκρίνας, δὲ μὲν τὰς ἀπορίας ἀπορίαις, δὲ ὅ τὰς τῶν ἐν τῇ Ἑλλάδι. ἔπειτα δὲ τοὺς ἀπὸ τῆς ἀπορίας ἀποκρίνας ἐκ δευτέρου τὰ ἀπορίαις. Polybius therefore did not well, (saith he) in making certaine Zones, which are to be limited by the Arctique circles: two of which lie under the said Arctiques, and two other terminated betwixt the Arctiques and the Tropicques. For this is a Maxime: that determinate things cannot be bounded by uncertaine and indeterminate limits. This their Philosophy therefore is vaine and frivolous. But yet their impudence ends not so. For you shall hardly meet with any of these Mathematicians, that will not presently conclude him madde, that should but dare to dissent any way from the doctrine of Iohn de Sacrobosco, in the point of these circles: Yet one of them not long since, being as it seemes, advised thereto by the former edition of Manilius, confesseth by the way, and as it were unwillingly, that the Ancients made other use of the Arctique circles, then we now doe. And yet he would not be thought to have learned this of me: notwithstanding these kind of fellows are the most ignorant in matters of Antiquity in the world. Who should be the first broker of this ridiculous conceit, I cannot guess, otherwise, then that it must needs be some latine Writer, and that 400. yeares later then any of the Greeke Authors. And I know not whether any

any other taught this doctrine before Iohn de Sacrobosco: certainly he is the most ancient I can readily thinke on. As therefore our men are in an error, in making the Arctique to be an Immutabile circle, so likewise are the Ancients, and those among us that follow them, to be blamed, for making this circle to be Parallel to the other three: whereas the Parallel circles in a Sphere have the same Pole with the Sphere it selfe. But the Pole of the Arctique is the same alwayes with the Pole of the world: whereas the Pole of the other three altereth, as doe the Tropicall and Equinoctiall points. For the Equinoctiall and Tropicall points doe anticipate their places in the Zodiacque: insomuch that in a certaine tearme of yeares they are removed forward a degree. Now the Equinoctiall and Tropicall circles, are no other then what are described by those points, which in themselves are moveable. Therefore are their Poles also moveable. But wee shall suffer for those things too, I doubt not, untill that length of time shall have beaten this into the heads of such men, with whom strength of reason is able to prevails nothing at all.

And this is the opinion of Scaliger, and the Ancients, concerning the Arctique circles: which Iohannes Pincierus, a learned man, in his lib. 2. cap. 13. Parergor. Otij Marpurg. hath lately examined, and endeavoured to confute the Arctique circle (saith he) is thus described by Proclus. Arcticus circulus, &c. The Arctique circle is the greatest of all those circles that are alwayes in sight, and it toucheth the Horizon in

one point, and is seene all above the earth. And the *Antarctique* he defines thus. The *Antarctique* is a circle equall and Parallel to the *Arctique*, and lies wholly hid under the earth. These circles therefore, in the opinion of Proclus, are moveable, and are described by a point that toucheth the Horizon about the Pole that is nearest to it: and they are also changed, with the Horizon, as often as a man moveth either Northward or Southward. So that the nearer they are to the Pole, the lesse they are: and so contrariwise the farther off they are from the same, they are so much the greater: and consequently it followes, because they have no fixed places, that therefore they cannot be described upon a Sphere or Globe.

But from hence there ariseth three inconveniencies. First, that these *Arctiques* described by Proclus, are not of any use in distinguishing the *Frigid Zone* from the *Temperate*, by reason of their uncertaine situation, and mutability. The next is, that with those that inhabit within twentie three degrees and an halfe of the Pole, (which is as much as the Sunnes greatest declination from the *Equator*) the *Arctique* circle will bee the same with the *Tropique* of Cancer, and the *Antarctique* with that of Capricorne. So that they will have but two lesser circles or *Parallels*, which will make but three Zones in all, two cold ones, and a torrid. For in this confusion of the circles, there will bee no distinction betwixt the cold, and the temperate Zones. And which is more, they that dwell under the *Equator*, will have

no Arctiques at all. Lastly, there are certaine accidents proper to certaine Climates, which cannot bee assigned them, unlesse there bee fixed and certaine limits set to distinguish the cold Zones from the temperate.

As for example: If it bee enquired, what properties are incident to those that inhabite betwixt the Tropique of Cancer and the Arctique circle: and what to those under the Arctique circle it selfe: and lastly what betwixt the Arctique circle, and the Pole of the world. To these questions there can bee no answer made without these fixed Arctique circles. Besides this, it would take away much light and furtherance, both from Geographicall Maps, and Astronomicall instruments, if these Arctique circles might not bee described in them: which could not possibly bee described in them, but that they must change evermore with the Horizon.

These and the like inconveniencies are easily avoided, by placing the Arctique circle, as usually it is, on the Poles of the Zodiacque. Neither am I any way swaied with the Authority of Ioseph Scaliger, adhering to Proclus his Doctrine of the mutability of the Arctique Circle: although I am not ignorant, how rare a thing it is, for such a Judgment, matched with so great knowledge, to fall into an error. And as for that testimonie which they bring out of Strabo, lib. 2. Geogr. that it is sufficient, if there be Arctique circles in the temperate Climes, and that those that have any, have

have not all the same : this is *id est* idle
(to use Straboes own words) nothing to the argu-
ment in hand, and concludes nothing. For then
they should bee of no use at all. I cannot there-
fore assent to a man, whose Tenet is dissonant both
from the nature of the thing, and reason it selfe.

But to returne at length to Proclus : who see-
ing that hee acknowledgeth that there are five
Zones : two of which are terminated betwixt the
Poles and the Arctique and the Antarctique cir-
cles : and other two bordering upon the same which
are the two temperate Zones, and are bounded on
one side by the Arctique, and on the other by the
Tropickes : betwixt both which lieth the Torrid
Zone : hee himselfe seemes tacitely to approve
these Immoveable Arctiques, without which
there can bee no set constant limits of the Frigid
and temperate Zones.

Thus Scaliger and Pincierus. Now concern-
ing the opinion that the Ancients had of these
Zones, namely that some of them were inhabited
through extreame cold, and some through parch-
ing heat : notwithstanding these are discovered at
length to be but vaine dreames, by the late Sea-
voyages both of the Portugals and our owne
Countrymen : yet can it not be denied, but that in
each of them there are certaine speciall and pecu-
liar Occurrences. So that, if but for doctrine
sake, it were good that these circles should not
bee taken away. Neither are wee to despise
it, if by the industry of later times, any thing
both becom added to the inventions of the Anci-
ents, which may any whit bee usefull for the
instruction.

instruction of learners, or may any way conduce to the clearing of things in themselves obscure and intricate.

CHAP. III.

Of the three Positions of Sphere: Right, Parallel, and Oblique.



According to the diverse habitude of the Equator to the Horizon, (which is either Parallel to it, or else cutteth it, and that either in Oblique, or else in Right Angles,) there is a threefold Position or situation of Spheres. The first is of those, that have either Pole for their Verticall point: for with these the Equator and Horizon are Parallel to each other, or indeed rather make but one circle betwixt them both. The 2^d. is of those whose Zenith is under the Equator. The third agreeth to all other places else. The first of these situations is called, a Parallel Sphere: the second a Right: and the third an Oblique Sphere. Of these severall kindes of position, the two first are simple: but the third is manifold and diverse, according to the diversity of latitude of places. Each of these have their peculiar properties.

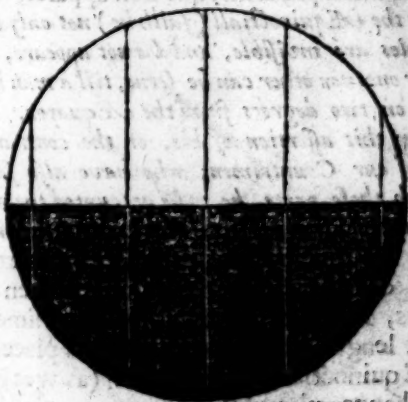
Those



Those that inhabite in a Parallel Sphere, see not the Sun or other Stars, either rising or setting, or higher or lower, in the diurnall revolution. Besides, seeing that the Sun in his yearly motion traverseth the whole Zodiacque which is divided by the Æquator into 2. equall parts: one whereof lieth toward the North, and the other toward the South; by this means it comes to passe, that while the Sun is in his course through those signes that are nearest their Verticall Pole, all this while hee never setteth, and so maketh but one continued Artificiall day; which is about the space of six moneths. And so contrariwise, while he runneth over the other remoter signes, lying toward the Opposite Pole, hee maketh a long continuall night of the like space of time, or thereabout. Now at such time as the Sun in his diurnall revolution shall come to touch the
very

very Equator, he is carried about in such sort, as that hee is not wholly apparent above the Horizon, nor yet wholly hidden under it: but as it were, halfe cut off.

The affections of a Right Sphere are these. All the Stars are observed to rise and set in an equall space of time: and continue as long above the Horizon, as they doe under it. So that the day and night is alwaies here of equall length.



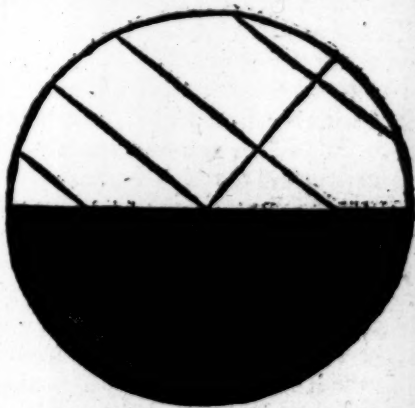
PONT. That in a Right Sphere all the Stars doe both rise and set, that is, are all generally scene above the Horizon, and in like manner doe also all set by turnes; so likewise that both the Poles, both Arctique and Antarctique may be scene at once: hath hitherto bene the received opinion both of Geminus, and Proclus, and generally of all other Writers: Which our Author also here followeth.

Ter

Yet if we doe but examine the matter more narrowly, we shall find this to agree not so much with the Sensible, as with the Rationall or Intelligible Horizon. For as much as even in a Right Sphere, the sight can hardly reach both the Poles; by reason of the extuberancy of the earth. Which is also confirmed by the Testimony of Iohannes Lerius a Burgonian, who in his history of his voyage into the New World, writeth thus. Non modo sub Aequinoctiali polus uterque non apparet; &c. Under the Aequinoctiall (saith he) not only both the Poles are invisible, and doe not appeare, but neither one, nor other can be seene, till a man hath passed on two degrees from the Equator. But whether this assertion of his, or the contrary of some of our Countymen, who have also sailed through those parts, be to be accounted the more accurate and true, I leave to other to determine.

An Oblique Sphere hath these properties. Their dayes are sometimes longer then the Nights, sometimes shorter, and sometimes of equall length. For when the Sun is placed in the Aequinoctiall points, which (as wee have said) happeneth twice in the yeare; the daies and nights are then equall. But as he draweth nearer to the elevated Pole, the dayes are observed to increase, and the nights to decrease; till such time as hee comes to the Tropique, when as he there maketh the longest dayes and the shortest nights in the yeare. But when he returneth toward the Opposite Pole, the dayes then decrease, till he toucheth the Tropique that lieth nearest the same Pole.

at which time, the nights are at the longest, and the dayes shortest. In this position of Sphere also, some Stars are never scene to set; such as are all those that lie within the compasse of a Circle described about the Elevated Pole, and touching the Horizon: and some in like manner are never observed to appeare above the Horizon: and these are all such Starres as are circumscribed within the like circle drawne about the Opposite Pole:



These Parallel circles (as wee have said) are those which the Greekes, and some of the Latines also, call the Arctique and Antartique circles, the one alwayes appearing; and the other alwayes lying hid. All the other Statres; which are not comprehended within these two circles, have their risings and settings by course. Of which those that are placed between

betweene the *Æquator* and this alwayes-apparent circle, continue a longer space in the upper Hemisphere, and a lesse while in the lower. So on the contrary, those that are nearer to the Opposite circle, are longer under the Horizon, and the lesse while above it. Of all which Affections this is the cause. The Sunne being placed in the *Æquator*, (or any other Starre) in his daily revolution describeth the *Æquinoctiall* circle: but being without the *Æquator*, he describeth a greater, or lesser Parallel, according to the diversity of his declination from the *Æquator*. All which Parallels, together with the *Æquator* it selfe, are cut by the Horizon, in a Right Sphere, to right angles. For when the Poles lie both in the very Horizon, and the *Zenith* in the *Æquator*: it must needs follow, that the Horizon must cut the *Æquator* in right angles, because it passeth through its Poles. Now because it cutteth the *Æquator* at right angles; it must also necessarily cut all other circles, that are Parallel to it, in right angles: and therefore it must needs divide them into two equall parts. So that if halfe of all these Parallels, as also of the *Æquator*, be above the Horizon, and the other halfe lye hid under it: it must necessarily follow, that the Sunne, and other Starres must bee as long in passing through the upper Hemisphere, as through the lower. And so the daies must be as long as the nights; as all the Stars in like manner will bee 12. houres above the Horizon, and as many under it. But in an Oblique

lique Sphere, because one of the Poles is elevated above the Horizon, and the other is depressed under it: all things happen cleane otherwise. For seeing that the Horizon doth not passe through the Poles of the *Æquator*, it will not therefore cut the *Parallels* in the same manner, as it doth the *Æquator*: but those *Parallels* that are nearest to the elevated Pole, will have the greatest portion of them above the Horizon, and the least under. But those that are nearest the opposite Pole, will have the least part of them scene, and the greatest part hid: only the *Æquator* is still divided into two equall parts, so that the conspicuous part is equall to that which is not scene. And hence it is that in all kinds of *Obliquitie* of Sphere, when the Sun is in the *Æquator*, the day and night is alwayes of equall length. And as he approacheth toward the elevated Pole, the dayes encrease; because the greater Arch, or portion of the *Parallels* are scene. But when he is nearer the hidden Pole, the nights are then the longest, because the greatest segment of those *Parallels* are under the Horizon. And by how much the higher either Pole is elevated above the Horizon of any place, by so much the dayes are the longer in Summer, and the nights in Winter.

PONT. *The position or situation of Sphere is rightly distinguished by our Author, into three kinds, to wit, Parallel, Right, and Oblique. Notwithstanding Clavius, with Sacrobosco, acknowledge onely two: and they are, Right and Oblique.*

lique. For if it be demanded, (saith Clavius) what manner of Sphere they may be said to have, that inhabite under the Poles: we must make answer, an Oblique. But both Clavius, and Sacrobosco are herein deceived. For those that have such a position of Sphere, as that they dwell under the Pole, the Equator with them doth not make Oblique angles with the Horizon: because the Horizon and Equator there make both but one circle. This kinde of Sphere therefore may more rightly be called a Parallel, or Neutrall Sphere: because that its Verticall point falleth upon the Pole of the Sphere. But Ioseph Scaliger hath given it the aptest appellation of all, in his Notes upon Manilius, Astronom. lib. 3. upon these Verses.

Stantis erit cali species, laterumque meatus
Turbinis in morem rectâ vertigine currit.

Where he saith, that every Sphere may be said, aut jacere, sedere, aut stare, either to lye, sit, or stand. So that the first position of Sphere is, as of lyeing all along, which is that of a Right Sphere, where the Horizon makes right angles with the Equinoctiall. The second is of sitting, *ἵκει* *ἱκεῖν*. The third is of standing, *ἵκει* *ἱκεῖν* and is like a Mill. For in this Position, the Equinoctiall supplying the office of the Horizon, and as it were turned round about, is just like a Hand mill, both in habit, and manner of turning about. But we cannot so properly call it a Right Sphere, because of the Right Angles that it makes with the Equinoctiall, as passing through its Poles: because that that appellation seems to suite more
fitly

fly with a standing Sphere, in which the Equinoctiall is the same with the Horizon and Arctique circle. Lastly, there is but one Right, or Lying Sphere, because there is but one Equinoctiall: and there are but two standing Spheres; because there be but two Poles. But there is great variety and diversities of Oblique; or sitting Spheres, as may manifestly appeare to any man; and as our Author hath declared at large.

CHAP. IIII.

Of the Zones.

THe foure lesser Circles, which are Parallel to the Equator, divide the whole earth into 5 parts, called by the Greekes Zones. Which appellation hath also beene received, and is still in use among all our Latine Writers: notwithstanding they sometimes also use the Latine word, *Plaga*, in the same signification. But the Greekes do sometimes apply the word *Zona*, to the Orbes of the Planets, (in a different sense then is ever used by our Authors) as may appeare by that passage of *Theon Alexandrinus*, in his Commentaries upon *Aratus*. *ἑξήκοντα ἡμέρας ἔχει, καὶ ἐνταύθι τοὺς ὡς ἀπὸ τοῦ οὐρανοῦ ὡς τὸν οὐρανὸν ἔχει ὁ Κρόνος. τὴν δὲ δέκα ἡμέρας ἔχει ὁ Ζεὺς.* that is: There are also in the heavens seven Zones, which are not contiguous to the Zodiaque; the first whereof is assigned to *Saturne*, the second to *Iupiter*, &c.

Of these five Zones, three were accounted

by the Ancient Philosophers and Geographers to bee inhabitable and intemperate. One of them by reason of the Sunnes beames continually beating upon the same : and this they called the *Torrid Zone*, and is terminated by the Tropiques on each side. And the other two by reason of extreame cold they thought could not be inhabited, as being so remote from the heate of the Sunnes beames : whereof one was comprehended within the Arctique circle, and the other within the Antarctique. But the other two were accounted temperate, and therefore habitable, the one of them lying betwixt the Arctique circle and the Tropique of *Cancer* ; and the other betwixt the Antarctique and the Tropique of *Capricorne*.

Neither did this opinion, (although in a manner generally received among the Ancients) concerning the number and bounds of the Zones, even then want its opposition. For *Parmenides* would have that Zone, which they call the Terrid, to be extended farre beyond the Tropiques : so that he made it almost as large againe as it ought to have beene : but is withall reprehended for it by *Posidonius*, because he knew that above halfe of that space which is contained betwixt our Summer Tropique and the *Aequator*, was inhabited. So likewise *Aristotle* terminated the Torrid Zone betwixt the Tropiques, and the temperate Zones with the Tropiques and the Arctique and Antarctique circles. But he also is taxed by the same *Posidonius*, in that he appointes the Arctique

Arctique circles, which the Greekes will have to be mutable, to be the limits of the Zones. *Polybius* makes sixe Zones, by dividing the Torrid into two parts, and reckoning one of them from the Winter Tropique to the Æquinoctiall, and the other from thence to the Summer Tropique. Others following *Eratosthenes*, would have a certaine narrow Zone, which should be temperate and fit for habitation, under the Æquinoctiall line: of which opinion was *Avicen* the *Arabian*. And some of our Moderne Writers, (as *Nicolaus Lyranus*, *Thomas Aquinas*, and *Campanus*) I know not upon what grounds, will have the terrestriall Paradise, spoken of in the beginning of *Genesis*, to be placed under the Æquinoctiall line. And so likewise *Eratosthenes* and *Polybius* would have all that which they call the Torrid Zone, to be temperate. In like manner *Pofidonius* contradicted the received opinion of the Ancient Philosophers, because he knew that both *Syene*, which they place under the Tropique of *Cancer*, and also *Ethiopia*, which lieth more inward, and over whose heads the Sun lieth longer, then it doth upon theirs under the Æquator, are notwithstanding inhabited. Whence he concluded, that the parts under the Æquinoctial were not uninhabitable, because he saw that those under the Tropique wanted not inhabitants. Yet *Ptolomy* in his 2^d. booke and sixe Chapter of his *Almagest*, conceiveth all those things, which are reported of the temperatenesse under the line, to be rather con-

jecture then truth of story : and yet in the last Chapter of his fifth booke of his *Geography*, he describes us a Country in *Ethiopia*, which he calleth *Agisymba*, and placeth farre beyond the *Equinoctiall* ; (notwithstanding some of our Moderne Ceographers sticke not to place it Northward from the *Equator*, contrary to *Ptolomies* mind.) This inconstancy of *Ptolomy* hath given occasion to some to suspect, that the *Almagest*, and *Cosmography* were not the same Authors workes.

Now as concerning these conceits of the Ancients, about the number of the intemperate Zones, if they were not sufficiently proved to bee vaine and idle, by the authority of *Eratosthenes* and *Polybius* : yet certainly it is very evidently demonstrated by the Navigations both of the *Portugals*, and also of our own Countrymen, that not only that tract of land, which the Ancients call the Torrid Zone, is fully inhabited ; but also that within the Arcticque circle, above 70. degrees from the *Equator*, all places are full of inhabitants. So that now no man needs to doubt any further of the truth of this ; unlesse he had rather erre with Sacred and Venerable Antiquity, then be better informed by the experience of Moderne Ages, though never so strongly backed with undeniable proofes and testimonies.

PONT. Whereas our Author accuseth *Ptolomy* of inconstancy, in that in his *Almagest*. cap. 6. lib. 2. he accounts it a fable rather than any
true

true history, whatso ever is reported of the inhabitants under the Equator: whereas in his Geography lib. 5. cap. ult. he seemeth to contradict the same: I think that Pliny also is not free from the like faults. For whereas in his lib. 6. cap. 22. having discoursed of the Magnitude of the Isle Taprobanc, (which is now thought to be Sumatra, and lyeth directly under the line,) out of Eratosthenes and Megasthenes: he presently addes, that besides the testimony of the Ancients, the Romans had better knowledge of the same, in the time of the Emperour Claudius, there being Embassadors sent from thence to Rome; who among other things should relate, that with them Gold and Silver was in high account, and that they had greater wealth then the Romans themselves; but yet that the Romans had greater use of riches, then they. Which words of Pliny, with many other there at large set downe by him, if they beo but compared with what himselfe elsewhere writeth, in his 2^d. booke cap. 68. he will be found manifestly to contradict himselfe. For disputing in this place, and inquiring how great a part of the earth is inhabited: Tres (saith he) terræ partes abstulisse nobis cælum, &c. Three parts of the world the Heavens have robbed us of; to wit, the Torrid, or middle Zone, that is, whatsoever lieth betwixt the two Tropiques: and the two outmost or Frigid Zones: that is to say, what ever ground lieth betwixt either Pole, and the Arctique and Antarctique circles. According to that which the Poet sung of old:

Quarum

Quarum quæ media est, non est habitabilis
æstu.

Nix regit alta duas.

In English thus :

The midst of these is not inhabited,

Through heat : and two with snow are covered.

For this is that which Pliny meaneth : that those two outward most are not habitable, by reason of extreameity of cold, nor the other, through too violent heat. But that which is more to be wondered at in so great an Author, (who notwithstanding indifferently tooke up as well the common popular fables, as the extravagant fictions of the Poets also,) is that which he very confidently relates out of Corlius Nepos, how that one Eudoxus, taking Ship in the Arabian gulse, came as farre as the Gades, two Isles upon the confines of Spaine. Which voyage if wee should but thoroughly examine, will be found to be as much, as that all the Portugals, and our Countrymen at this day performe in their Sea voyages to the East Indies, when as touching upon the Cape of good hope, they twice crosse the line, and passe through the whole Torrid Zone. Not to speake any thing of that which he writeth in his sixth booke, twentie third Chapter, Namely, that there is never a yeare, that India doth not sucke out of the Romane Empire, at the least 500000. Sestercies, by sending in such commodities, as they sell to the Romanes for an hundred times as much as they are worth in India. And that there is yearly Traffique by Shippe through the Red Sea, betwixt them and the Romanes, who are faine for their safer passage, so defend

deſend themſelves from Pirates, by going provided with bandes of Archers. And here all that can bee ſaid in Plinies defence, is, that thoſe things which he relates in his ſecond booke, were written by him long before the reſt which followeth: and that at that time theſe Indian voyages were not ſo frequently undertaken, or the paſſages ſo well knowne unto the Romanes: eſpecially for that in the bookes following, as namely the ſixth booke, 17. and 23. Chapters, he ſaith, that the whole courſe of the voyage from Egypt into India, began but then firſt to be diſcovered, when as he was writing the ſame: and that Seneca having not long before begun a deſcription of India, reckoned up therein 60. great rivers, and 122. Nations, to be contained within the ſame.

The principall cauſe of the habitableneſſe and fertility of the parts under the Torrid Zone, is, in that the Sun ſhineth upon them but 12. houres: ſo that the nights being alwayes as long as the dayes, the coldneſſe of the one doth very much attemperate the exceſſive heate of the other. In like manner, that both the Frigid Zones are habitable, is to be attributed to the Sun, which in his courſe through the fixe Northerne ſignes of the Zodiacke, never ſets in fixe moneths ſpace to thoſe that live under 84. degrees of latitude: ſo that by his continuall preſence the extreame rigidity of the Clime is mitigated, and the cold by this meanes diſpelled.

CHAP. V.

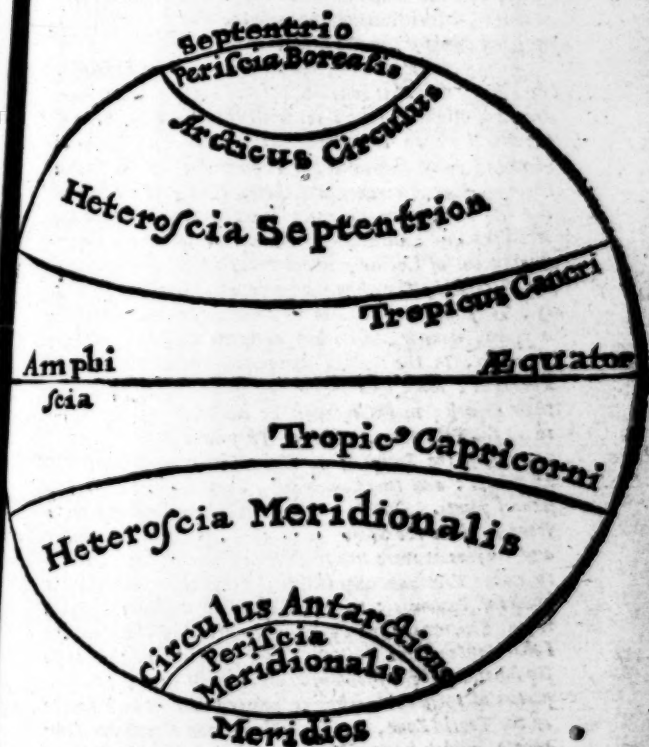
Of the Amphiscij, Heteroscij, and Periscij.



He inhabitants of these Zones, in respect of the diversity of their noon-shadows are divided into three kinds, *Amphiscij*, *Heteroscij*, and *Periscij*. Those that inhabite betwixt the two Tropiques are called *Amphiscij*, because that their noone-shadows are diversly cast, sometime toward the South, as when the Sunne is more Northward then their Verticall point: and sometimes toward the North, as when the Sun declines Southward from their Zenith.

Those that live betwixt the Tropiques and Arctique circles, are called *Heteroscij*, because the shadows at noone are cast only one way, and that either North or South. For the Sunne never comes farther North, then our Summer Tropick; nor more Southward, then the Winter Tropicke. So that those that inhabite Northward of the Summer Tropique, have their shadows cast alwayes toward the North: as in like manner those that dwell more Southward then the Winter Tropicke, have their Noone-shadows cast alwayes toward the South. Those that inhabite betwixt the Arctique or Antarctique circles, and the Poles, are called *Periscij*: because that the *Gnomons* doe cast their shadows circularly; and the reason hereof is, for that the Sun is caried round about above their Horizon in his whole diurnall Revolution,

A figure of all these may here be seene :



PONT The Heterosciall Zone is therefore twofold, either Northern or Southerne. The Northern is comprehended betwixt the Tropique of Cancer and the Arcticus circle; and is called *Septentrionalis*, because that in it the Sun-beames at noone are alwayes cast to that part onely that lieth toward the Pole Arcticus.

The

The Southerne Heterocliall Zone, containeth all that space of ground that lieth betwixt the Tropique of Capricorne, and the Antarctique circle. And it is called *Tropicus*, Meridionalis; because the Noone shadows are projected toward the South Pole onely.

The properties of these severall Zones are these that follow. First, they that inhabite the midst of the Torrid Zone, are in a Right Sphere: for with them both the Poles of the world lie in their Horizon: and their Zenith or Verticall point falleth in the Equinoctiall Circle. So that their peculiar Accidents are these. First, All the Starres doe rise and set in an equall space of time, except the Arctique and Antarctique Poles: as wee have demonstrated out of Lælius, in our notes upon the third Chapter. Secondly, They have a perpetuall Equinox. Thirdly, They have the Sunne verticall unto them twice in a yeare, namely, when hee entereth into γ and ϵ . Fourthly, In the Sunnes Periodicall motion through the Zodiaque, looke how much hee goeth Southward from their Zenith, in his returne he declines as farre Northward from the same. Fifthly, They have foure Solstices: two when the Sunne is in their Zenith and Equinoctiall points: and two Collaterall, when hee is in the Solsticiall points. Sixthly, They have two Summers every yeare, when the Sunne is in the Equinoctiall points: and two as it were winters, when the Sunne declineth to either Tropique. Seventhly, They have five different kindes of shadows: to wit, Eastward, Westward, Northward, Southward, and Perpendicular. And therefore the Inhabitants of this Zone are called *Amphiscij*, that is to say, having their shadows cast on both sides: The properties of those that inhabite toward the utmost border of the Torrid Zone, and beginning of the Northerne Temperate, which have an Oblique Sphere, (for the Arctique Pole with them is elevated twenty-three gr. and an halfe, and their Zenith falleth on the Tropique of Cancer,) are these following. First, All those Starres that are comprehended within the compasse of the Arctique Circle, are alwayes above their Horizon: and contrariwise those within the circuit of the Arctique alwayes

lye hid. But of the intermediate Starres those that are Northward from the Equator, are a longer time above the Horizon, then they are under it: in like manner as the other that decline more Southward, their Nocturnall Arch is greater than the Diurnall: onely those in the line it selfe doe rise and set in an equall space of time. 2. Their Artificiall dayes and nights are un-equall. 3. The Sunne is in their Zenith but once in the yeare, and that is in the beginning of Cancer: so that it never ascends more Northward, but at all other times is Southward to them. 4. They have two Solstices: one when the Sun is in the beginning of Cancer, which is their Verticall point: and the other when the Sun entereth into the beginning of Capricorne, at which time the Sun hath the least elevation. 5. They have also but one Summer and one Winter. They have foure differences of shadowes, namely Easterne, Western, Northerne, and Perpendicular. And here is the beginning of the Heteroscij.

They that dwell in an Oblique Sphere, so that the Arctique Pole is elevated with them above 23. gr. and an halfe, but lesse then 66. gr. and an halfe: their Zenith or Verticall point alwayes falleth betwixt the Tropique of Cancer, and the Arctique Circle: whence they have these properties. 1. Very many Starres with them are never observed to set: for the higher the Pole is elevated, the more Stars there are which alwayes appeare; and so in like manner there are as many in the opposite Hemisphere that never rise. 2. Their Artificiall dayes and nights are unequal. 3. The Sunne

Sunne is never in their Verticall point: but is alwayes at Noone Southward from them. 4. They have one Summer, and one Winter, and two Solstices. 5. They have also thre different kinds of shadowes, as namely Eastward, Westward, and Northward. Whence they are called Heteroscij.

Those that inhabite about the end of the Northerne temperate Zone, have the Pole Arctique elevated with them 66. degrees and an halfe: so that their Zenith falleth on the Arctique circle: whence they have these properties of Sphere. 1. All the Starres that lye within the Tropique of Cancer and the Pole Arctique are of perpetuall Apparition: and contrariwise, those that are comprehended within the Opposite circle, are never seene to rise. 2. When the Sunne is in the beginning of Cancer, the Artificiall day is with them twentie foure houres in length: and so likewise when the Sunne entreteth into Capricorne, the nights are as long. 3. The Sun at noone is alwayes Southward to them: but when he is in the beginning of Cancer, and is neare the very Horizon, he then seemes in a manner to be Northward. 4. They have two Solstices, and one Summer, and one Winter. 5. They have foure differences of shadowes: as namely Easterne, Westerne, Southerne and Northerne also, especially when the Sunne entreteth into the beginning of Cancer. About these parts the Heteroscij end, and the Periscij begin.

Those that inhabit about the middle of the Northerne Frigid Zone, have a Parallel or standing Sphere: for the Equinoctiall is their Horizon, whence they have consequently these properties.

1. No

1. No Starres either rise or set at all: but whatsoever are circumscribed within the Equinoctiall circle and the very Pole, are caried about in circles Parallel both to the Equinoctiall, and Horizon. 2. For the space of 6. moneths they have one continued day, the Sunne in this space finishing his course through the Northerne signes of the Zodiaque: and so likewise while he is in the opposite meridionall signes; they have a night of the same length. 3. They have but one Solstice, and that is, when the Sun entresth into the beginning of Cancer. 4. They have one winter and one Summer, or rather instead of a Summer, they have some certaine small remission of the extremitie of cold. 5. Their shadowes are caried round about them in a circle toward every part of the world: whence they are called Periscij, that is to say, having their shadowes caried round about in a circular forme.

These are the properties of the Northern Zones; which if they bee referred to the opposite meridionall parts also, you have their properties likewise. For whatsoever is said of one Hemisphere, the same is also to be understood of the other opposite Hemisphere, only in a contrary sense. For when these that dwell in the Superiour Hemisphere have their longest day, the opposite inhabitants in the meridionall part of the world have their shortest; and when they have their Summer, with these it is then winter &c. And the same is also to be understood of the other Accidents also, concerning their shadowes, the rising and setting of the Starres, and the like.

CHAP. VI.

Of the *Periaci*, *Antaci*, and *Antipodes*.

THe Inhabitants of the temperate Zones have by the Ancient Geographers been divided, in respect either of the same Meridian, or Parallel, or else equal situation in respect of divers parts of the *Æquator*, in such sort, as that in every habitation in these severall parts, they have added three other different in position, whose inhabitants they called, *Periaci*, *Antaci*, and *Antipodes*.

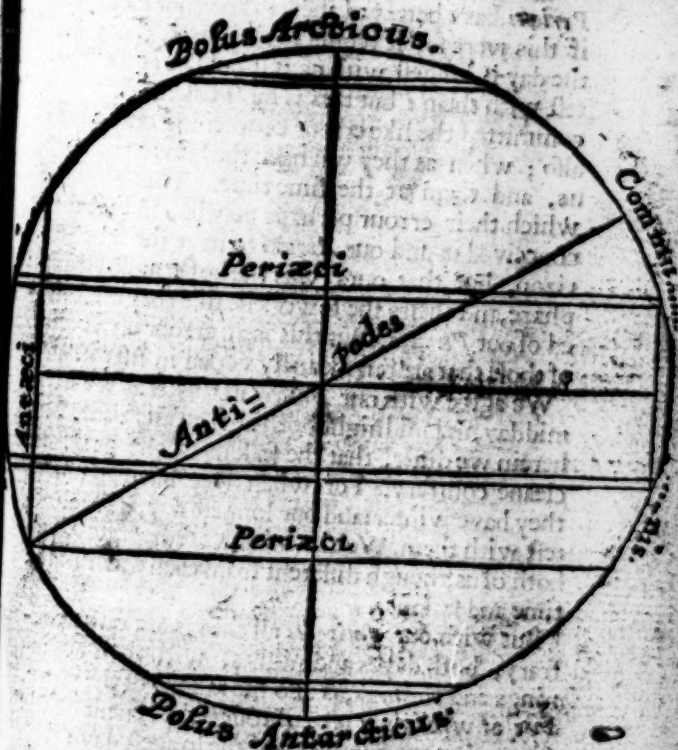
Periaci are those that live under the same Meridian, and the same Parallel also, being equally distant from the *Æquator*; but in two opposite points of the same Parallel.

Antaci are such as have the same Meridian, but live in diverse Parallels, yet equally distant from the *Æquator*, though in diverse parts.

Antipodes, (which are called *Antichthoni*) are such as inhabite under one Meridian, but under two diverse Parallels, which are equally distant from the *Æquator*, and in opposite points of the same: or else wee may define them to be, such as inhabite two places of the earth, which are Diametrically opposite.

They therefore which are *Periaci* in respect of us, are *Antaci* to our *Antipodes*: and those that are *Antaci* to us, are *Periaci* to our *Antipodes*: and

and our *Periaci*, are *Antipodes* to those which are *Antaci* to us.



We have also many accidents common with our *Periaci*. For we both inhabite the same temperate Zone; and have Summer, Winter, increase and decrease of daies and nights at the same time. Only this difference is betwixt us, that when it is noon with us, it is midnight with them. Those Authors

that have added this difference also, that when the Sun riseth with us; it setteth with those that are our *Periaci*, have betrayed their own ignorance. For if this were so, it would then follow, that when the day is longest with us, it should be at the shortest with them: but this is most false. They have committed the like error concerning our *Antaci* also; when as they will have the Sun to rise with us, and them at the same time. The ground of which their error perhaps may be, in that they conceived us and our *Antaci* to have the same Horizon, but that ours was the uppermost Hemisphere, and theirs the lower: the like they conceived of our *Periaci*. But this is an error unworthy of those that are but meanely versed in Astronomy.

We agree with our *Antaci* in this, that we have midday, and midnight both at the same time. But herein we differ, that the seasons of the year are cleane contrary. For when wee have Summer, they have winter: and our longest day, is the shortest with them. We also inhabite temperate Zones both of us, though different from each other in the time and seasons.

But with our *Antipodes* all things are quite contrary, both dayes and nights, with their beginnings and endings, as also the seasons of the year. For at what time we, through the benefit of the Sun, enjoy our Summer and the longest day: then is it winter with them, and the daies at the shortest. So likewise when the Sun riseth with us, it setteth with them; and so contrariwise when it setteth with us, it riseth with them. For we inhabite the upper Hemisphere, and they the lower, divided by the same Horizon.

CHAP. VII.

Of Climates and Parallels.

ACcording to the different quantity of the longest dayes, Geographers have divided the whole Earth, on each side of the Equator to the Poles, into Climates and Parallels. A Climate they define to be a space of earth comprehended betwixt any two places, whose longest dayes differ in quantity halfe an houre. And a Parallel is a space, wherein the dayes increase in length a quarter of an houre. So that every Climate containeth two Parallels. Those Climates, as also the Parallels themselves are not all of equall quantity. For the first Clime, (as also the Parallel) beginning at the Equator, is larger then the second, and the second is likewise greater then the third. Only herein they all agree, that they differ equally in the quantity of the longest day.

The Ancients reckoned but 7. Climates at the first; to which number were afterward added two more; so that in the first of these numbers were comprehended 14. Parallels, but in the later, 18. *Ptolomy* accounting the Parallels by the difference of a quarter of an houre, reckoneth in all 24. by whole houres difference 4. by whole moneths, 6. So that besides the Equator, reckoning the whole number of Parallels on each side, they amount to 38.

In the Meridian of a Materiall Globe there

are described nine Climates, differing from each other by the quantity of half an houre. After these there are other also set according to the difference of an whole houre: and last of all those that differ in whole months are continued to the very Pole, each of them expressed in their severall latitudes. The distances of all both Climates and Parallels, together with their latitudes from the Equator, and differences of the quantity of the longest days, are here fully exprest in this Table following.

Amplifcy.

Climates	Ser.	The longest Latitude and the Summers day leuation of Pole				The breadth of the Climates	
		Mour.	Ser	Hour.	Ser.	Deg.	Scrup.
0	0	12	0	0	0	4	18
	1	12	15	4	18		
1	2	12	30	8	34	8	35
	3	12	45	12	43		
2	4	13	0	16	43	7	30
	5	13	15	20	33		
3	6	13	30	23	10	7	3
	7	13	45	27	36		

Flower of the.

4	8	14	0	30	47	6	9
	9	14	15	33	45		
5	10	14	30	36	30	5	17
	11	14	45	39	2		
6	12	15	0	41	22	4	30
	13	15	15	43	32		
7	14	15	30	45	29	3	48
	15	15	45	47	20		

Heterogij.

Climate.	Parallels.	The longest summer day		Latitude and Elevation of the Pole.		The breadth of the Climates.	
		Hour.	Scr.	Degr.	Scr.	Degr.	Scr.
8	16	16	0	49	1	3	13
	17	16	15	50	33		
9	18	16	30	51	58	2	44
	19	16	45	52	27		
10	20	17	0	54	39	3	17
	21	17	15	55	34		
	22	17	30	56	37	2	0
11	23	17	45	57	34		
	24	18	0	58	26	1	40
12	25	18	15	59	14		
	26	18	30	59	59	1	26
13	27	18	45	60	40		
	28	19	0	61	18	1	13
14	29	19	15	61	51		
	30	19	30	62	23	1	1
15	31	19	45	62	54		
	32	20	0	63	22	0	52
16	33	20	15	63	46		
	34	20	30	64	6	0	46
17	35	20	45	64	30		
	36	21	0	65	49	0	36
18	37	21	15	65	6		
	38	21	30	65	21	0	29
19	39	21	45	65	35		
20	40	22	0	65	47	0	22
	41	22	15	65	57		
21	42	22	30	66	6	0	17
	43	22	45	66	14		
22	44	23	0	66	20	0	11
	45	23	15	66	25		
23	46	23	30	66	28	0	5
	47	23	45	66	30		
24	48	24	0	66	31	0	0

Months

Here the Climates begin to be accounted by months, from 66. gr. 31. m. where the day is 24. hours long: unto the Pole it self, where it is 6. months in length.

1	67	13
2	69	30
3	71	30
4	73	30
5	74	30
6	75	0

Perijij.

[illegible]



The second Part,

CHAP. I.

Of such things as are proper to the Caelestiall Globe: and first of the Planets.



hitherto hath our discourse bene concerning those things which are common to both *Globes*: We will now descend to speake of those that properly belongs to each of them in particular, And first of those things that only concerne the *Caelestiall Globe*: as namely the Stars, with their severall configurations.

The whole number of Starres hath been divided, by the Ancient Astronomers, who first applied themselves to the diligent observing of the same, into two kinds. The first is of the Planets, or wandring Starres: the other of the fixed. The first of which they therefore called Planets or Wanderers, because they observe no constant distance or situation, neither in respect of each other, nor in respect of those that are called fixed Starres. And these were so called, because that they were observed

ved alwayes to keepe the same situation and distance from one another, as is at large proved by Ptolomy, in his *Almagest*, lib. 7. cap. 1. out of his owne observations, diligently compared with those delivered by Hipparchus.

PONT. The Starres are divided into Planets, or wandering Starres, and fixed: not as if these were indeed fixed in one certaine place, and altogether without motion, and the other only moveable and erraticall: but these appellations are only given then comparatively; in which sense also they are to bee understood. For seeing that the fixed Starres were observed alwayes to keepe the same places in the eighth Sphere, and the same distance from each other: notwithstanding that they are alwayes in continuall motion, caused by the vertue of the first Moveable, which carrieth them about in the space of twenty foure houres. But the Planets, besides this motion, have a proper motion of their owne, so that they keepe neither the same distance from the fixed Starres, nor yet the same aspect to each other: for these reasons were the one called Fixed, and the other Planets. For otherwise if the Planets be considered severally, each one by himselfe, there is nothing more certaine then their peripodicall motions: So that Tully, alluding hereto, would have the Planets to bee called Errantes, by an Amphiphrasis, quasi minime errantes.

The Planets, (excepting those two greater lights, the Sunne and Moone) are five in number

number. All which, beside the Diurnall motion, by which they are carryed about from East to West, by the Rapture of the first Moveable, have also a free proper motion of their owne, which they finish from West to East, according to the succession of the Signes, upon the Poles of the Zodiaque, each of them in a severall manner and space of time: Their order in the Heavens, and periods of their motions being such as followeth.

Saturne, called in Greeke Κρόνος, or Φαίμαρ, (and by *Julius Higinus*, *Stella Solis*, the Starre of the Sunne) is the highest of all the Planets: and goeth about the greatest circuit: but doth not therefore appeare to be the least of all the Planets, as *Pliny* thence conjectured. Hee finisheth his Periodicall course in twenty nine yeares, five moneths, fiftene dayes, according to *Alfraganus*.

Jupiter, in Greeke Ζεύς, and Φαίδωρ, moveth through the Zodiaque in the space of eleven yeares, tenne moneths, and almost 16. dayes.

Mars, Ἄρης and Πυρραία, (which is also called by some, *Hercules* his Star) finisheth his course in two yeares.

Sol, the Sunne, in Greeke Ἡλιός, performeth his course in a yeare, that is to say, three hundred sixtie five dayes, and almost fixe houres.

Venus, Ἀφροδίτη, (called by some *Juno's* Starre, by others, *Iris*, and by others, *The Mother of the Gods*:) when it goeth before

fore the Sunne, it is called *Phosphorus*, the day Starre, appearing like another lesser Sunne, and as it were maturing the day. But when it followeth the Sunne, in the Evening, protracting the light after the Sunne is set, and supplying the place of the Moone; it is then called *Evenus*, the Evening Star. The nature of which Star, *Pythagoras Samius* is said first to have observed about the thirtieth 2^d. Olympiad, as *Pliny* relates, lib. 2. cap. 8. It performeth its course in a yeares space, or thereabout: and is never distant from the Sunne, above fortie sixe degrees, according to *Timaeus* his computation. Notwithstanding our later Astronomers, herein much more liberall then he, allow it two whole signes, or 60. degrees, which is the utmost limit of its deviation from the Sunne.

Mercury, in Greeke *Eurus*, and *Σηλαβω*, (called by some *Apollo's* Starre) finisheth his course through the Zodiaque in a yeare also: And according to the opinion of *Timaeus* and *Sosigenes*, is never distant from the Sunne above 25. gr. or as our later writers will have it, not above a whole signe, or 30. degrees.

Luna, *Σελήνη* the Moone, is the lowest of all the Planets, and finisheth her course in twentie seven dayes and almost eight houres. The various shapes and appearances of which Planet, (seeming sometimes to be Horned, sometimes equally divided into two halves, sometime figured like an Im-

perfect

perfect circle, and sometimes in a perfect circular forme,) together with the other diversities of this Starre, were first of all observed by *Endymion*; as it is related by *Pliny*: whence sprung that Poëticall fiction, of his being in love with the Moone.

All these Planets are caried in Orbes which are *Eccentricall* to the earth: that is, which have not the same center with the earth. The Semidiameter of which Orbes, compared to the Semidiameter of the earth, have this proportion, as is here set downe in this Table.

Of what parts the Semidiameter of the Earth is. 1. Of the same the Semidiameter of the Orbe of	<i>Luna</i>	Is	48.	56.	m.
	<i>Mercury</i>		116.	3.	m.
	<i>Venus</i>		641.	45.	m.
	<i>Sol.</i>		1165.	23.	m.
	<i>Mars</i>		5032.	4.	m.
	<i>Jupiter</i>		11611.	31.	m.
	<i>Saturne</i>		17225.	16.	m.

The Eccentricities of the Orbes, compared to the Orbes themselves, have this proportion.

Of what parts the Semidiameter of the Deferent is 60. Of the same the Eccentricity of	<i>Luna</i>	is	13.28.m.30.sec.	} Magnitudines, out of Alphab.
	<i>Mercury</i>		2. 0. m.	
	<i>Venus</i>		1. 8. m.	
	<i>Sol</i>		2. 16. m. 6. sec.	
	<i>Mars</i>		6. 0. m.	
	<i>Jupiter</i>		2. 45. m.	
	<i>Saturne</i>		3. 25. m.	

The Eccentricities of some of the Planets, (especially of the Sunne) are found to have decrea-

decreased and grown lesse since *Ptolemies* time. For *Ptolomy* sets down the Eccentricity of the Moone to be 12. gr. 30. m. but by *Alphonfus* it was found to be but 13. gr. 28. m. and an halfe. *Ptolomy* assigned Eccentricity to *Venus* 1. gr. 15. m. *Alphonfus* 1. gr. 8. m. *Ptolomy* found by his owne observations. and also by those that *Hipparchus* had made, that the Eccentricity of the Sun was 2. gr. 30. m. *Alphonfus* observed it in his time to be but 2. gr. 16. m. and the 10th. part of a minute. In the yeare of our Lord 1312. it was found to be 2. gr. 2. m. 18. sec. *Copernicus* found it to be lesse yet then that and to be but 1. gr. 56. m. 11. sec. So that without just cause did the Illustrious *Iulius Scaliger* thinke *Copernicus* his writings for this reason to deserve the Sponge, and the Author himselfe the Bastinado: herein dealing more hardly with *Copernicus*, then he deserves.

PONT. Besides the Eccentricities of the Planets, it is worth our paines also to observe their Magnitudes: And this consists especially in the knowledge of their Diameters, and what proportion they beare to each other. For the Diameter of a Planet, compared to the Diameter of the Earth, is after this manner following.

The Diameter of	Saturne	compared to the Di ameter of the Earth is as	9	to	2
	Jupiter		32		7
	Mars		7		6
	Sol		11		2
	Venus		3		10
	Mercury		1		28
	Luna		5		17

The

The Diameter of the Sun compared to the Diameter of the Moone, beareth the same proportion that is betwixt 187. and 10.

And now that which is said may be demonstrated by an example: let us suppose the Diameter of the Sun in proportion to the Diameter of the Earth, to be, (as is already shewed) as 11. to 2. The Cube therefore of the Sunne is 11. and the Cube of the Earth. 2. Now these Diameters being multiplied cubically, and the greater Cube divided by the lesse, the difference of their severall Globes will appeare. For if you multiply 11. by 11. there ariseth 121. which number being multiplied againe by 11. the whole will be 1331. So likewise multiply 2. cubically, that is to say, by it selfe, and there riseth 4. which being againe multiplied by 2. ariseth 8. Now divide the greater Cube, 1331. by 8. and the product will be 166½. which is the difference of the Globes of the Sun and the Earth.

And thus much may suffice us to have spoken of the Planets: and if any desire a more copious Narration of the same, they may have recourse to *Ptolemy*, *Copernicus*, and others, that have written the Theories of the Planets. For a more large description of these things seemes not to stand with our purpose: especially for that by reason of their Erraticall motion, they cannot be expressed in a *Globe*. Let thus much therefore be spoken of them, as by the way only.

CHAP. II.

Of the Fixed Stars, and their Constellations.

And here in the next place we intend to speake of the Fixed Stars, and their *Asterismes*, or *Constellations*, which *Pliny* calls *Signa* and *Sidera*, signs. Concerning the number of which Constellations, as also of their figures, names, and number of the Stars they consist of, there is diversity of opinion among Authors. For *Pliny* in his 2^d. book, 41. chap. reckoneth the whole number of the signs to be 72. But *Ptolomy*, *Alfraganus*, and those which follow them, acknowledge but 48. for the most part: notwithstanding some have added to this number one, or two more; as *Berenices Hair*, and *Antinous*. *Germanicus Caesar*, and *Festus Avienus Rufus*, following *Aratus*, make the number lesse. *Julius Higinus* will have them to be but 42. reckoning the *Serpent*, and *The man that holdeth it*, for one signe: and he omitteth the little *Horse*: and doth not number *Libra* among the signs: but he divideth *Scorpio* into two signs; as many others also doe. Neither doth hee reckon the *Crow*, the *Wolfe*, nor the *South Crowne* among his Constellations, but only names them by the way. The *Bull* also, which was described to appeare but halfe, by *Hipparchus*, and *Ptolomy*, and those that follow them: the same is made to be wholly apparent, both by *Virruvius*, and *Pliny*, and also before them, by *Nicander*, if we may believe *Theon*, *Aratus* his Scholiast: who also place the *Pleades* in his backe.

Congr.

Concerning the number also of the Starres, that goe to the makeing up of each Constellation, Authors doe very much differ from *Ptolemy*; as namely, *Julius Higinus*, the Commentator upon *Germanicus*, (whether it bee *Bassus* as *Philand:r* calls him: or whether those Commentaries were written by *Germanicus* himselfe; as some desire to prove out of *Lactantius*) and sometimes also *Theon*, in his Commentaries upon *Aratus*; and *Alfraganus* very often.

Now if you desire to know what other reason there is, why these Constellations have beene called by these names, save onely that the position of the Starres doth in some sort seeme to express: the formes of the things signified by the same: you may read *Bassus*; and *Julius Higinus*, abundantly discoursing of this argument out of the fables of the *Greekes*. *Pliny* assures us, (if at least we may beleve him) that *Hipparchus* was the man that first delivered to posterity the Names, Magnitude, and Places of the Starres. But they were called by the same names, before *Hipparchus* his time; by *Timochares*, *Aratus*, and *Eudoxus*. Neither is *Hipparchus* ancienter then *Aratus*, as *Theon* would have him to be. For the one flourished about the 420. yeare from the beginning of the Olympiads: as appeareth plainly out of his life written by a Greeke Author. But *Hipparchus* lived above 600. yeares after the beginning of the Olympiads: as his observations delivered unto us by *Ptolemy* doe sufficiently

ently testific. Besides that there are extant certaine Commentaries upon the *Phænomena* of *Eudoxus* and *Aratus*, which goe under *Hipparchus* his name : unlesse perhaps they were written by *Eratosthenes* (as some rather thinke) who yet was before *Hipparchus*.

PONT. That which is written of *Hipparchus*, is not to be understood any further, then touching the distinction of the Starres of the first, second, and third magnitude. For so *Servius* in his Commentaries upon the 1. lib. *Geogr.* *Hipparchus* (inquit) scripsit de ignis, &c. *Hipparchus* (saith he) wrote of the Signes, and reckoned up, how many bright Starres, how many of the second degree of light, and how many obscure Starres there were in each Constellation. For otherwise, that the Starres were knowne by the same names 1000. yeares before *Hipparchus*, may be proved out of *Seneca*, who in his 7. lib. *Natural. Quæst.* cap. 25. saith thus. *Nondum sunt anni, &c.* It is not (saith he) 1500. yeares yet since Greece first began to number the Stars, and to give them certaine Appellations, Now *Seneca*, we know, was put to death by the command of *Nero*, in the 65. yeare after Christ. And *Hipparchus* lived not above 283. yeares before Christ, in the time of *Ptolomæus Philadelphus*. And *Iob* also, whom *Philo Iudæus* reporteth to have married *Dina*, *Jacob's* daughter, mentioneth these names, *Arcturus*, *Pleiades*, and *Orion*, if we may trust *St. Hierom's* translation in this case, cap. 9. vers. 9. Who maketh (saith he) *Arcturus*, *Orion*, and *Pleiades*, and the

the Starres in the remotest parts of the South. So likewise the Prophet Amos, chap. 5. vers. 8. *Querite (inquit) opificem Pleiadum & Orionis. &c. Seeke ye him that made the Pleiades and Orion, &c.*

Now it is probable, that there were two kinds of men, that reduced the Starres into Constellations: and these might probably be Husbandmen, and Mariners. The Husbandmen perhaps might make these, to wit; the Ram, the Bull, the Eare of Corne in the Virgins hand, the young Kids, the Goate, the Waggoner, the little Goate; the Waggon: all which are names used also by Homer. Of the Mariners, the Pleiades, the Hyades, the Whale, and the like names seeme to have beene invented: according to that of Virgil, in the first of his *Georgicks*.

*Navita tum Stellis numeros & nomina fecit:
Pleiades, Hyades, clarumq; Lyaonis Astrum!*

Which is thus translated into English Verse
by T. May.

The Sailers numbred then, and nam'd each Star:
The Pl-iads, Hyads, and the Northern Carre.

And to whom doe those other new Constellations about the Antartique Pole, owe their now so well knowne names, but to the Portugals, Hollander, and English Sea-faring men? Neither are those men at all to be regarded, that condemn these usuall names of the Starres, and Constellations, as unfit to be used by Christian men. For seeing they are now used, without the least shew of superstition, and that there is very great necessity of these Appellations, in as much

as without them there could be no agreement or accord in these Artes and Sciences. (for these very names are used all the world over, where ever the same Artes are taught or professed) I see no reason but that we may lawfully use these names, till such time as, the true names, wherewith the great Creator of all things at the first called every Star, as David witnesseth in the 146. Psalme, be made knowne unto us. As concerning the practise of the Arabians, who rejecting these humane figures, have substituted in their places the formes of beasts: you may read Ioseph Scaliger, in his Commentaries upon Manilius.

Pliny in his 2. booke, 41. chapter affirmeth, (though I know not upon whose authority or credit) that there are reckoned 1600. fixed Starres, which are of notable effect and vertue. Whereas Ptolemy reckoneth but 1022. in all, accounting in those which they call *Sporades*, being scattered here and there, and reduced to no Asterisme. All which, according to their degrees of light, he hath divided into 6. orders. So that of the first Magnitude he reckoneth 15. of the second, 45. of the third, 208. of the fourth, 474. of the fifth, 217. of the sixth, 49. to which we must adde the 9. obscure ones, and 5. other, which the Latines call *Nebulosa*, cloudy Starres. All which Starres, expressed in their severall Constellations, Magnitudes, and names, both Latine and Greeke, (and some also with the names by which they are called in Arabique) you may see described in the Globe.

Erasmus Reinbolt; where every one of these Starres is reckoned up, with his due longitude, latitude, and magnitude annexed.

PONT. You may also see *Christophorus Clavius* in his *Commentary* upon *Iohan. de Sacrobosco*, cap. 1. And above all the rest *Tycho Brahe*; who in his booke of the *New Starre* that appeared in the yeare 1572. hath proposed tables of the longitude and latitude of all the fixed Stars that can conveniently be seene in these Climates, according to his owne most accurate observations: as you may see in the aforementioned booke, pag. 258. and so forward.

But here you are to observe by the way, *Copernicus* and *Erasmus Reinbolt* doe reckon the longitude of all the Starres, from the first Starre in *Aries*: but *Ptolomy* from the very Interfection of the *Equinoctiall* and *Eclipticke*. So that *Victorinus Strigelius* was in an error, when he said, that *Ptolomy* also did number the longitude of Starres from the first Starre the head of *Aries*.

CHAP. III.

Of the Constellations of the Northern Hemisphere.



He first is called in Latine *Ursa Minor*, and in Arabique *Dub Alasgar*, that is to say, the lesser Beare, and *Alrucaba*, which signifieth a Wagon or Chariot: yet this name is given

given also to the hindermost Starre in the
taile, which in our time is called the Pole
Starre, because it is the nearest to the Pole of
any other. Those other two in the taile, are
called by the Greekes *χοοδρομι*, that is to say,
Saltatores, Dancers. The two bright Stars
in the fore part of the body, the *Arabians* call
Alferkathan, as *Alfraganus* writeth: who al-
so reckoneth up seven Starres in this Constel-
lation, and one unformed neare unto it. This
Constellation is said to have beene first in-
vented by *Thales*, who called it the *Dog*, as
Theon upon *Aratus* affirmeth.

The second is *Vrsa Major*, the *Great Beare*:
in Arabique, *Dub Alacber*. The first Starre
in the backe of it, which is the 16. in number,
is called *Dub* *κατ' ἀρκτῶν*, and that which is in
the flanke, being the 17. in number, is called
Mirae, or rather, as *Scaliger* would have it,
Mizar, which signifieth (saith he) *locum*
praeinfectionis, the girthing place. The first in
the taile, which is the 25. in number, is called
by the *Alfonsines*, *Aliare*; and by *Scaliger*,
Aliath. This *Asterisine* is said to have beene
first invented by *Nauplius*, as *Theon* affirmeth.
It hath in all 27. Starres: but as *Theon* reck-
oneth them, but 24. Both the Beares are
called by the Greekes, according to *Aratus*,
αυρεα, which signifieth a *Wagon* or *Chariot*.
But this name doth properly appertaine to
those seven bright Starres in the great Beare,
which doe something resemble the forme of a
wagon. These are called by the *Arabians*,

Boneth As; i. e. *Filia Feretri*, as *Christmannus* testifieth. They are called by some, though corruptly, *Benenas*, and placed at the end of the taile. Some will rather read it *Bonethasch*, which signifies *Filium Vrsæ*. The Grecians in their navigations were wont alwayes to observe the great Beare; whence *Homer* gives them the Epithere *Ἰκωνος* as *Theophrastus* observeth: for the Greekes call the great Beare *Ἰκων*. But the *Phanicians* alwayes observed the lesser Peare, as *Aratus* affirmeth.

The third is called the *Dragon*, in Arabique *Athamin*, and it is often called *Aben*; but *Scaliger* readeth it, *Taben*; whence he calleth that Starre which is in the Dragons head, and is the 5. in number, *Rastaben*, though it be vulgarly written *Rasaben*. In this Constellation there are reckoned 31. Starres.

The fourth is *Cepheus*, in Arabique *Abedaf*. To this Constellation, besides those two unformed Starres, which are hard by his *Tzara*, they reckon in all, 11. among which, that which is in number the 4. is called in Arabique *Atteraimin*, which signifieth, the right Arme. This Constellation is called by the *Phanicians* *Pbicaret*, which is interpreted *Flammiger*, which appellation peradventure they have borrowed from the Greeke word *πυρραγος*.

The fifth is *Bootes* *Ἰκωνος*, which signifieth in Greeke an *Heardsman*, or one that driveth Oxen.

Oxen. But the Arabians mistaking the word, as if it had beene written *ῥοῦς* of *Βόας*, which signifies *Clamator*, a Cryer, call it also *Alhava*, that is to say *Vociferator*, one that maketh a great noyse or clamor; and *Alfamech Alramech*, that is, the Launce-bearer. Betwixt the legs of this Constellation, there stands an unformed Starre of the first Magnitude, which is called both in Greeke and Latine, *Arcturus*, and in Arabique *Alramech*, or the brightest Starre, *Somech haramach*. This Starre *Theon* placeth in the midst of *Bootes* his belt or girdle. The whole Constellation consisteth of 22. Starres.

PONT. There is mention made of *Asturus* also in *Iob*, cap. 9. vers. 9. according both to *Hieroms* translation, and also the Greeke translation of the 70. as we have noted already. But in the Hebrew text it selfe, it is called *Gnashch*, or *Asch*. from the roote *Gnushch*, which signifieth *Congregabit*. *Hesychius* in his *Onomasticon* observeth that *Bootes* is also called sometimes *Orion*: according to that of *Manilius*.

Arctos & Orion adversis frontibus ibant.

In which signification *H. Grotius* in his notes upon *Aratus* his *Asterismes*, thinks it is here to be taken. Sometimes also the whole Constellation of *Bootes*, or *Arctophylax*, is called *Arcturus*; from the Greeke word *ἄρκτος*, a Bear, and *ῥος*, which is the same that *φυλάξ*, a Keeper: as *Scaliger* upon *Manilius* observes. Now that the Hebrewes call *Arcturus* by a word signifying a congregating, or gathering together, the reason

I take to be, because he hath the great Beare joy-
ned to him. For this Starre standeth behinde
the taile of the great Beare, whence it seemeth to
have it's name, quasi ἀρκτος ἑποσ the keeper of the
Beare, whence Pliny also, lib. 2. cap. 41. Bootes
sequitur Septentriones.

The sixth Constellation is *Corona Borea*,
the North Crowne, called by the *Arabians*,
Adilafchemali, and that bright Starre, which
is placed where it seemeth to be fastened to-
gether, and which is the first in number, is cal-
led in Arabique *Alphecca*, which signifieth *Sol-
utio*, an untying or unloosing. It is also cal-
led *Munic*: but this name is common to all
bright Starres. The whole Constellation con-
sisteth of eight Starres.

The seventh is *Hercules*, in Arabique *Al-
cheti hale rechabatch*, that is, one falling upon
knees, and sometimes absolutely *Alcheti*: for
it resembleth one that is wearied with labour
(as *Aratus* conceives) whence it is also called
in Latine *Nisus*, or *Nixus*; (which in *Vi-
truvius* is corrupted into *Nessus*:) and the
Greekes call it *εργισαν* that is to say, One on his
knees. The Starre which is first in number
in the head of this Constellation, is called in
Arabique *Rasacheti*, not *Rasaben*, as the *Alfon-
ses* corruptly have it: and the 4. Starre is
called, *Marsic*, or rather *Marsic*, *Reclinatori-
um*, that part of the Arme on which we leane.
The eight Starre, which is the last of the three
in this Arme, is called *Maxim*, or *Maasim*,
which signifieth, *Strength*. This Constella-
tion

tion hath eight Starres, besides that which is in the end of his right foote, which is betwixt him and *Bootes*, and one unformed Starre at his right Arme.

The eight is the *Harpe*, called in Latine *Lyra*, in Arabique *Schaliab*, and *Alvakah*, i. e. *Cadens* sc. *Vulture*, the *Falling Vulture*. It consisteth of 10. Starres, according to *Hipparchus* and *Ptolomy*: but *Timochares* attributed to it but 8. as *Theon* affirmeth: and *Alfraganus* 11. The bright Starre in this Constellation, being the first in number, *Alfonsus* calleth *Vega*.

The ninth is *Gallina*, or *Cygnus*, the *Hen*, or *Swan*, and is called in Arabique *Aldigaga* and *Altayr*, that is, the flying *Vulture*. To this *Asterisme* they attribute, besides those two informed neare the left wing, 17. Starres, the 5. of which is called in Arabique, *Deneb Aldigege*, the taile of the *Hen*; and by a peculiar name *Arided*, which they interpret, *quasi redolens lilium*, smelling as it were of *Lillies*.

PONT. And here in this place it is worth our noting, that there was a new Starre observed in the breast of the *Swanne*, in the yeare 1600. Which set many *Mathematicians* on worke: and among the rest, besides *Iustus Byrgius* Engineer to the Emperour, *Iohannes Beierus*, *Martine*, and others: *Iohan. Kepler* also, who had sometime bene *Tychoes* Scholler, put forth a *Mathematicall Tract* of it, when it had now continued in the same place of that constellation for the space of 6. yeares, being a Starre about the third *Magnitude*.

The

The 10th is *Cassiopeia*, in Arabique *Dharb Alcurfi*, the Lady in the Chayre : and it consisteth of 13. Starres : among which the 1st. in number *Alfonsus* calleth *Scheder*, *Scaliger Soder*, which signifieth a Breast.

PONT. There was another new Star also appeared in *Cassiopeia*, being as great as a Starre of the first Magnitude, in the yeare 1572. Novem. 11.th and it lasted 11. Monethes. Of which Starre there were divers opinions among Astronomers : yet they all agreed in this, that it was placed in the seat of *Cassiopeia* in the very Skie, and in *Via lactea*. And those that had observed it more accurately (and among the rest the Noble *Tycho Brahe*, who also wrote a large Volume of the same, full of most accurate observations) did all of them unanumously confesse, that they could not perceive that it had any Parallaxe at all, nor yet distinguish any difference betwixt its True and Apparent place ; and also added, that it alwayes kept the same situation in the Eighth Sphere. Whence they manifestly are refuted, who deny that there hath ever any new Starre risen in the heavens since the first Creation : among which is *Lambertus Danrus*, as may appeare in his *Physic. Christian. Tract. 4. cap. 10.* But he ought to have mentioned not this Starre onely, but also that other, which (as *Pliny* testifieth) was observed by *Hipparchus* to have bene generated in the very Skie it selfe in his time. For whereas the same *Danrus* thinks, that the Starre which appeared at our SAVIOURS Nativity, was either some Comet, or else some one of the Ordinary Stars,

Stars, which at that time kept an extraordinary course in its motion : the first of these cannot be granted ; because it is expressly called a *Starre* : neither is the second of any force, because it is not probable, that the Magi, who were so skilfull in the knowledge of the Stars, should be so much deceived, as to mistake an old *starre*, that had onely changed its place, for a new one. Neither yet doe we beleve this to be the same that Hipparchus is said to have observed in his time, or this other, which as we have said, was seene Anno. 1572. but rather that it was a different *Starre* from both. For further satisfaction whereof, I referre my reader to Tycho de Nova Stella pag. 319. &c.

The 11th is *Persens*, *Chamil Ras Algol*, that is to say, Bearing the head of *Medusa* : for that *Starre* which is on the top of his left hand, is called in Arabique *Ras Algol*, and in Hebrew *Rosch hassatan*, the Devils head. This constellation hath, besides those three unformed, 26. other Stars : of which that which is the seventh in number, *Alfonsus* calleth *Alchemib*, for *Alchemib*, or *Algeneb*, according to *Scaliger*, which signifieth a side.

The 12th is *Auriga*, the Wagoner, in Arabique *Roha*, and *Memassich Albanam*, that is, One holding the raines of a bridle in his hand. This Asterisme hath 14. Stars : of which that bright one in the left shoulder, which is also the third in number, is called in Greeke, *αὐξ* *Capra*, a Goate ; and in Arabique *Alhaiok*, or, as *Scaliger* saith, *Alatod*, which signifieth a He Goate : and the two which are in his left hand,

hand, and are the 8th and 9th, are called *ἑξαστοι* *Hexsti*, *Kids*; and in Arabique, as *Al-fonsus* hath it, *Saclateni*, but according to *Scaliger*, *Sadatani*, the hindmost arme. This Configuration of these Stars was first observed by *Cleostratus Tenedius*, as *Higinus* reporteth.

The 13th is *Aquila*, *Albhakab*, the Eagle: the moderne Astronomers call it, the flying *Vulture*, in Arabique *Altayr*: but *Alfraganus* is of a contrary opinion, for he calleth the Swanne by this name, as wee have already said. They reckon in this Asterisme 9. Stars, besides 6. other unformed, which the Emperour *Hadrian* caused to be called *Aminolus*, in memory of *Antonius*, his Minion.

The 14th is the *Dolphin*, in Arabique, *Aldolphin*, and it hath in it 16. Stars.

The 15th is called in Latine *Sagitta*, or *Telum*, the Arrow or Dart, in Arabique *Alfahan*: it is also called *Istust*, which word *Græci* thinkes is derived from the Greeke word *ἄκον* signifying an arrow. It containeth 5. Stars in all.

The 16th is *Serpentarius* the Serpent-bearer; in Arabique *Alhava*, and *Hafalangue*. It consisteth of 24. Stars, and 5. other unformed. The first Starre of these is called in Arabique *Rafalangue*.

PONT. There was also discovered a new Starre in the foot of the Serpent-bearer, Anno 1605. which might have beene reckoned among the Stars of the third magnitude. It began first to appeare about October in the yeare aforesaid, and

and about February the yeare following, being 1606. it vanished out of sight. Kepler wrote a Booke of this Starre also, unto whom you may have recourse for further satisfaction.

The 17th is *Serpens*, the Serpent, in Arabique *Alhasa*: it consisteth of 18. Stars.

The 18th is *Equiculus*, the little Horse, and in Arabique *Kataat Alfaras*, that is in Greek, *ὀστρεὸν ἵππος*, as it were, the fore part of a Horse cut off. It consisteth of 4. obscure Stars.

The 19th is *Pegasus*, the Great Horse, in Arabique *Alfaras Alathem*; and it hath in it 10. Stars. The Starre on the right shoulder, which is called *Almenkeb*, and is the third in number, is also called, *Seat Alfaras*, *Brachium equi*. And that which is in the opening of his mouth, and is numbred the 17th, is called in Arabique *Enif Alfaras*, the Nose of the Horse.

The 20th is *Andromeda*, in Arabique *Al-mara Almasulsela*, that is, the Chained Woman; *Alfraganus* interprets it, *Feminam, que non est experta virum*; A Woman that hath not knowen a man. This Constellation containeth in it 23. Stars: whereof that which is the 12th in number, and is in the girdling place, is commonly called in Arabique *Mirach*, or, according to *Scaliger*, *Mizar*: and that which is the 5th is called *Alamac*, or rather *Almaar*. which signifieth a socke or buskin.

The 21th is the *Triangle*, in Arabique *Almutaleh*, and *Mutlathum*, which signifies *Triplcity*.

plicitus. It consisteth of 4. Starres.

PONT. Among all these Constellations in the Northerne Hemisphere, which are in all 27. there are but three Stars onely of the first Magnitude. The first of which is that in the left shoulder of Erichthonius, or the Wagoner, called in Latine *Capella*. The second is the bright Star in the Harpe: and the third is *Arcturus*, betwixt the legs of *Bootes*. Now the whole number of Stars in this part of the heavens, reckoning in these also which are of the 2^d. 3^d. 4th. 5th. and 6th. magnitude, with the obscure and cloudy ones also, amount to 360.

CHAP. IV.

Of the Northerne Signes of the Zodiac.



The First is *Taurus*, the Ram, in Arabique *Alhamel*: this Constellation hath 13. Starres, according to *Ptolemy's* account; yet *Alfraganus* reckoneth but 12. besides the other 5. unformed ones, that belong unto it.

The 2^d is *Taurus*, the Bull, in Arabique *Altor*, or *Ataur*: in the eye of this Constellation there is a very bright Star, called by the Ancient Romans *Palisicium*, and by the Arabians *Aldebaram*, which is to say, A very bright Star, and also *Hain Altor*, that is, the Bulls eye. And those five Stars that are in his forehead, and are called in Latine *Sucula*, the Grecians

Grecians call *uadus* because, as *Theon*, and *Hero Mechanicus* conceive, they represent the forme of the Letter *Υ*. although perhaps it is rather because they usually cause raine and stormy weather. *Thales Milesius* said that there were two of these *Hyades*, one in the Northerne Hemisphere, and the other in the South: *Enripides* will have them to be 3. *Achæus* 4. *Hippius* and *Pherecides* 7. Those other 6. or rather 7. Stars, that appeare on the backe of the Bull, the Greekes call *Pleiades*, (perhaps from their multitude) the Latines *Vergilia*, the Arabians *Atauria*, quasi *Taurina*, belonging to the Bull. *Nicander*; and after him *Vitruvius*, and *Pliny* place these Stars in the taile of the Bull: and *His parchus* quite out of the Bull, in the left foot of *Perseus*. These Stars are reported by *Pliny* and *Solinus* to be never seene at all in the Isle *Taprobana*: but this is ridiculous; and fit to bee reported by none, but such as *Pliny* and *Selinus*. For those that inhabite that Isle, have them almost over their heads. This Constellation hath 33. Stars in it, besides the unformed Stars belonging to it, which are 11 in number.

PONT. Plines words in that place doe not seeme to carry any such sense simply, seeing that he addes the same also of the Beare. His words are these in his lib. 6. cap. 22. where speaking of certaine Embassadors that came from the Isle *Taprobana* to Rome, he saith; Septentriones, Vergiliaeque apud nos, veluti novo cælo, mirabantur. They wondred to see the Beare, and the

the seven Stars with us, as if they had been arrived in a new world. And certainly if Taprobane be situate under the very Line, this then, for that very reason we alleadged before on the 3. cap. par. 1. out of Icrius, had beene no such strange matter, if it had beene spoken of the Septentriones onely. Neither had Pliny written any so absurd a relation, if he had said thus. Septentriones apud nos, veluti novo cœlo, mirabantur.

In the meane time I could wish, that Authors would insert nothing in their bookes, without due examination : although I am not ignorant, that it is not strange to finde Pliny faultering now and then in these kinde of things.

The third is *Gemin*, the Twinnes, in Arabique *Algeuze*. These some will have to be *Castor* and *Pollux*, and others, *Apollo* and *Hercules* : whence with the Arabians the one is called *Acellar*, for *Aphellan* ; and the other *Abracaleus*, for *Gracelus* : as *Scaliger* conceiveth. It containeth in it, (besides the 7. unformed,) 18. Stars, amongst which that which is in their head, is called in Arabique *Rasalgeuze*.

The fourth is *Cancer*, the Crab, in Arabique *Alfartan*, consisting of 9. Stars, beside 4. unformed : of which that cloudy one which is in the breast, and is the first of all, is called *Mel-les* in Arabique, which, as *Scaliger* saith, signifieth thicke or well compact.

The fifth is *Leo*, the Lion, in Arabique *Alased* : in the breast whereof there is a very bright Starre, being the 8th in number, and is called
in

in Arabique *Kale Alased*, the heart of the Lion, in Greeke βασιλικη, because that those that are borne under this Starre, have a Kingly Nativity, saith *Proclus*. And that which is in the end of the taile, and is the last of all in number, is named *Deneb Alased*, that is to say, the taile of the Lion: *Alfraganus* calleth it *Asumpha*. This Constellation containeth in it 27. Stars, besides 8. unformed. Of the unformed Stars which are betwixt the hinder parts of the Lion, and the Great Beare, (according to *Ptolomies* account, although *Theon* following *Aratus*, reckons the same as belonging to *Virgo*.) they have made a new Constellation, which *Conon* the Mathematician, in favour of *Ptolomy* and *Berenice*, would have to bee called *Berenices Haire*: which story is also celebrated by the Poet *Callimachus* in his Verses,

The sixth is *Virgo*, the Virgin, in Arabique *Eladari*: but it is more frequently called *Sunbale*, which signifieth an Eare of Corne: and that bright Starre which she hath in her left hand, is called in Greeke, κορυς, an Eare of Corne, and in Arabique *Hazimeth Alhacel*, which signifieth an handfull of Corne. This Starre is wrongly placed by *Vitruvius* and *Higinus* in her right hand. The whole Constellation consisteth of 26. Stars, besides the 6. unformed.

CHAP. V.

Of the Constellations of the Southerne Hemisphere : and first of those in the Zodiac.



And first of *Libra*, which is the 7. in order of the Signes. That part of this Constellation which is called the Southerne Ballance, the Arabians call *Mizan Aliemin*, that is to say, *Libra dextra vel meridionalis*, the Right-hand or Southerne ballance. But *Libra* was not reckoned anciently among the Signes : till that the later Astronomers robbing the Scorpion of his clawes, translated the same to *Libra*, and made up the number of the Signes : whence the Arabians call the Northerne ballance, *Zubeneschi mali*, that is in Greeke ^{Βόρην} the North Claw, and the other part of it that looks Southward, they call *Zubenalginubi* ^{Ζην δὲ νότον} the South Claw. This Constellation containeth in it 8. Starres, beside 9. other unformed belonging to it.

The eight is *Scorpio*, the Scorpion, in Arabique commonly called *Alatrab*, but more rightly *Alacrab* : whence the Starre in the breast of it, which is the 8. in number, is called *Kelebalacrab*, that is, The Heart of the Scorpion : and that in the end of his taile, which is the second in number, they call *Leshar*, but more truly *Leshuth*, which signifieth the sting of

of any venomous creature, and by this word they understand the Scorpions sting. It is also called *Schomlek*, which *Scaliger* thinkes is read by transposition of the letters, for *Moslek*, which signifieth the bending of the taile. This Constellation consisteth of 21. Starres, besides 3. unformed.

The ninth is *Sagittarius*, the *Archer*, in Arabique *Elcufu*, or *Elcaufu*, which signifieth a Bow; it hath in it 31. Starres.

The tenth is *Capricornus*, the *Goate*, in Arabique *Algecli*. To this Constellation they attribute 28. Starres, among which that which is in number the 23. is called in Arabique *Denob Algedi*, the taile of the Goate.

The eleventh is *Aquarius*, the *Waterman*, in Arabique *Eldelis*, which signifieth a *Bucket* to draw water. The 10. Starre of this Constellation is called in Arabique *Seat*, which signifieth an *Arme*. It containeth in all 42. Stars.

The twelfth is *Pisces*, the *Fishes*, in Arabique *Alsemcha*. It containeth 34. Starres, and 4. unformed.

PONT. Among all the Constellations reckoned up by the Author in this and the precedent chapters, there are onely found 5. Starres of the first Magnitude. The first of which, is *Oculus Tauri*: the second, *Cor Leonis*; the third, *Cauda Leonis*: the fourth *Spica Virginis*: and the fift and last, is a starre about the mouth of the south Fish. The rest are all either of the 2. 3. 4. 5. or 6. magnitude, beside some certaine cloudy ones; which are reckoned in all to bee 346.

CHAP. VI.

Of the Constellations of the Southerne Hemisphere, which are without the Zodiacke.

THE first is *Cetus*, the Whale, called in Arabique *Elkaios*, consisting of 22. Starres. That which is in number the second, is commonly called *Menkar*, but more rightly, as Scaliger saith, *Monkar Elkaios*, the nose or snout of the Whale: and the 14. *Boten Elkaios*, the belly of the Whale: and the last of all save one, *Deneb Elkaios*, the taile of the Whale.

The second is *Orion*, which the Arabians call sometimes *Asugia*, the mad man; which name is also applied to *Hydra*: and sometimes *Elgeuze*. Now *Geuze* signifieth a *Wall-nut*: and perhaps they allude herein to the Latine word *Ingula*, by which name *Festus* calleth *Orion*: because he is greater then any of the other Constellations, as a *Wall-nut* is bigger then any other kinde of nut. The name *Elgeuze* is also given to *Gemini*. This Constellation is also called in Arabique *Algibbar*, which signifies a strong man, or Gyant. It consisteth of 38. Starres, among which that which is the second, and is placed in his right shoulder, is called *Ied Algeuze*, that is; *Orion's Hand*, as *Christmannus* thinketh: but more commonly *Bed Elgeuze*, and perhaps it should rather

rather be *Bet Elgeuze*, that is, the bright Star in *Orion*. The third Starre is called by the *Alfonsines Bellatrix*, the Warriar. That which is in his left foote, and is the 35. in number, is called *Rigel Algeuze*, or *Algibbar*, that is to say, *Orions* foote.

PONT. In the 9. Chap. of *Iob*, vers. 9. there is mention made of *Orion*, as we said before. Now the word in the Originall is *Kefil*, which signifieth *Madnesse*, *Rage*, and *Instability*: and it is so called perchance, because that when this Constellation riseth with the Sunne, it causeth great store of tempestuous weather in all places: whence it is stiled by the Poet, *Nimbofus* & *Aquosus Orion*. Now we must note, that this word *Kefil* in *Hebrew*, (which is rendred *Orion* by *Hierome* and others) doth answer to the *Arabique* word *Asugia*, which signifieth likewise a *Bold* or *Furious* fellow, as our Author saith. In like manner there is mention made of *Orion* againe in the 38. Chapter of *Iob*, vers. 31. *Nunquid cohibebis delicias Pleiadum, aut lora Orionis dissolves*: Canst thou bind the sweete influences of the *Pleiades*, or loose the bonds of *Orion*? notwithstanding *Interpreters* doe not all agree in rendring this place. Looke also in the *Prophet Amos*, Chap. 5. vers. 8.

The third is *Eridanus*, in *Arabique* *Aluabar*, that is to say, the River: whence *Nar*, the name of a River in *Hebræa*, is conceived by some to have beene contracted. It hath in it 34. Starres: among which that which is the 19. is commonly called in *Arabique* *Algetenar*,

getenar, but Scaliger rather thinkes it should be read *Anchenetenar*, which signifieth the winding or crooking of a River. The 29. Starre is also called *Beemim*, or rather *Theemim*, which signifieth any two things joyned together: so that it is to be doubted, whether, or no this name may not be as well applied to any two Starres standing close by one another. And the last bright Starre in the end of it, is called *Acharnabar*, as if you should say, Behinde the River, or, in the end of the River: and it is commonly called *Acarnar*.

PONT. Avienus calleth this River Nilus, in these verses of his.

---Pharium pars altera Nilum (amne.
Commemorat, largo segetes quod nutriat.
In English thus.

The other part relates of frui full Nile
Whose swelling streames enrich the Pharian Ile.
And Plautus also hath an elegant Periphrasis of the same in his Trinummus, Scen. Huic ego. where he speakes thus: Ad caput amnis, quod de cælo exoritur sub folio Iovis. relating it as of a River that should spring out in the Heavens, from under Iupiters Throne.

The fourth is *Lepus* the Hare, in Arabique *Alarnebet*: and it containeth in all 12 Stars.

The fifth is *Canis* the Dogge, *Alcheleh Alachbar* in Arabique, the great Dog; and *Alfahare alimalija*, that is to say, the Right-hand or Southerne Dog. Which name, *Alfahare*, which is also sometime written *Scera*, Scaliger thinkes is derived from an Arabique word,

word, which signifieth the same that *ὑσποψία* in Greeke, a disease that mad Dogs are troubled with, when as they cannot endure to come neare any water. Notwithstanding *Grotius* is in doubt whether or no it should not rather be *Elseiri*, and so derived from the Greeke word *οειειρ*. For by this name is that notable bright Starre called, which is in the Dogs mouth, and is called in Arabique *Gabbur*, or *Echer*, and by corruption, *Habor*. This Constellation hath in it 11. Stars.

The sixth is the little Dog, called in Greeke *Procyon*, and in Latine *Antecanis*, because it riseth before the great Dog. The Arabians call it *Alchelh Alasgar*, that is to say, the lesser Dog, and *Alfabare alfemalija*, and commonly, though corruptly, *Algomeiza*, the left hand or Northerne Dog. This Asterisme consisteth of two Stars onely.

PONT. *There is extant a notable witty Epigram in Ausonius of the Cælestiall, Terrestriall and Marine Dogs; which may have reference to this place also, if so be that it be presented in it's proper meaning after this manner.*

*Trinacrij quondam currentem in littoris ora
Antecanis leporem cœruleus rapuit. (est:
At Lepus. In me omnis terræ, pelagique ruina,
Forsit an & Cœli; si Canis astra tenet.*

In English thus.

*As once a Hare came lightly tripping o're
The sandy bankes of the Trinacrian shore:
A Dog-fish caught her. Whereat she replies.
Land, Stars, and all, are still mine enemies.*

Not

Nor should I yet be more secure, I feare,
 In Heaven it selfe; if Dogs they harbour there,
 In which place Antecanis Cœruleus, in the
 second verse, signifieth a Sea-dog. Yet this place
 hitherto hath commonly gone thus, Ante canes
 leporem, &c. without any sense at all. Now
 the Poet in this place useth this word Antecanis,
 in imitation of Tully, who first of all Latine Au-
 thors, rendred Procyon, Antecanis: as mani-
 festly appeareth out of his translation of Aratus
 into Latine verse.

The seventh is *Argo*, the Shippe, in Ara-
 bique *Alsephina*; now *Sephina* signifieth a
 ship. It is also called *Merkeb*, which signifieth
 a Chariot: according as the Poets also usually cal
 it, ἀρμα θαλάσσιον as if one should say, a Sea-cha-
 riot, in stead of a ship. But the *Alfonsines* gave
 this appellation to that Star which is the 6.
 in number. The whole Asterisme containeth
 in it 45. Stars, of all which, that which is the
 last save one, is called in Arabique *Sobel*, or
Sybel, which signifieth Ponderous or weighty.
 Which Appellation they perhaps have given
 it, for the same reason, that *Bassus* hath ano-
 ther like it, which is, *Terrestris*, because it al-
 wayes appeareth to them very low, and neare
 the earth. The Greekes call this Star γάργαρος,
 the Hebrewes *Chefil*, as *Christmannus* is of o-
 pinion. Which if it be so, then *Arias Mon-*
tanus is in an error, in taking it for *Orion*, in
 his translation of the Itinerary of *Beniamin*
Tudelensis. The Inhabitants of *Azania* called
 it an Horse, as *Ptolomy* affirmes, in his *Geogra.*
lib. 5. cap. 7. The

The eighth is *Hydra*, in Arabique *Alſugabb*, or *Aſuia*, which ſignifieth Strong, or Furious. The *Egyptians* called it *Nilus*, as *Theon* writeth in his Commentaries upon *Aratus*. It hath in it, 25. Starres, beſides two unformed; the 12. of which the Alphonſines call *Alphart*.

The ninth is *Crater*, the Cup, in Arabique *Albatina*, and *Elkis*, which ſignifieth a Goblet or ſtanding Cup. It hath in it 7. Stars.

The tenth is *Corvus*, the Crow, *Algorab* in Arabique, conſiſting of 7. ſtarres.

The eleventh is *Centaurus*, the Centaure, called by the ſame name in Arabique. It containeth 37. Stars: among which, thoſe that are in his hinder ſeete, are the Stars that make up the Croſſe, ſo much celebrated in the Spaniſh Navigations.

The twelfth is *Fera*, the Wild-beaſt, called in Arabique *Aſida*, ſignifying a Lionefſe, and *Alſubabb*, which alſo is taken for a Wolfe, or other ravenous beaſt. To this Conſtellation they reckon 19. Stars.

The thirteenth is *Ara*, or *Thuribulum*, the Altar, or Cenſer, in Arabique *Almugamra*: *Baffus* calleth it *Sacrarium*. It containeth 7. Stars.

The foureteenth is *Corona Australis*, the South Crowne, in Arabique *Alachil Algenubi*: it conſiſteth of 13. Stars, making up a double wreath, according to *Alfraganus*: yet *Theon* reckoneth but 12. in it.

The fifteenth is *Pifcis Austrinus*, the South Fiſh, *Abant algenubi* in Arabique. It containeth

taineth in it 12. Starres in *Ptolemies* account, but 11. onely according to *Alfraganus*. Among which the bright one that is in his mouth, is called *Phom Abut*, that is to say, the mouth of the Fish, and commonly by corruption, *Fomahant*.

There is also described in the Cœlestiall Globe a certaine broad Zone or circle, of the colour of milke, which representeth that which appeareth in the Heavens, and is commonly called *Via Lactea*, the milky way. Which Zone or circle is not drawne regularly or equally, either in respect of latitude, colour, or frequency of Stars; but is different and various both in forme and situation, in some places appeareing but as a single circle, and againe in others seeming as it were dividing in two parts. The delination wherof you may see in the Globe, and the description more largely set downe by *Ptolomy* in his *Almagest*, lib. 8. cap. 2.

PONT. This part of the Heavens hath in it 7. Stars of the first Magnitude, whereof the first is in the right shoulder of Orion: the second, in his left foote: the third, in the end of the River Eridanus; the fourth, in the mouth of the great Dog, which they call *Sirius*: the fift, in the thigh of the Little Dog, called *Procyon*: the sixth, is *Canobus*, in the ship *Argo*: and the seventh, is in the right foote of the Centaure. To which we may adde of the second magnitude, 18. of the third, 60. of the fourth 168. of the fift, 53. of the sixth, 9. and one cloudy one. All which are in the generall, 316.

Now

Now the whole Firmament, reckoning in the Northerne and Southerne Hemifpheres, together with the Zodiague, containeth in all 1022. Stars, which make up 48. Aſteriſmes or Conſtellations. Neither did either Ptolomy, or Hipparchus before him know any more then theſe. Notwithſtanding Pliny, as our Author hath advertiſed before in the ſecond Chapter, made the number of Stars and Conſtellations a great deale larger. But of this we ſhall ſpeake more in the end of the next Chapter. And concerning thoſe Conſtellations, which have beene more lately obſerved about the South Pole by the Portugals and Hollanders, and by them named, we intend to ſpeake ſomething in the end of the Chapter following.

CHAP. VII.

Of the Starres which are not expreſſed in the Globe.

BEſides theſe Stars which we have here reckoned up out of Ptolomy, there are yet many other to be ſeene ſometime, eſpecially in the winter time, in a cleare night, when as there are both many more Stars to be ſeene, then at other times, and thoſe that are ſeene, appeare by much greater. Now if you expect that we ſhould aſſigne the cauſe of this: we might anſwer, that it is beſides the intention of our preſent purpoſe. Yet for your ſatiſfaction, and becauſe that ſome Authors have very
much

much erred from the right, in setting downe the true reason of the same: we doe therefore the more willingly make this digression. For some there are, who (out of the extraordinary knowledge they have in Philosophy, and Optickes) would very willingly perswade us, that either we conceive them to be more, then indeed they are, and that our sense only is deceived: or else (which is altogether as ridiculous) that the ayre being in winter more pure and thin, maketh them more conspicuous, which otherwise in t^e Summer, when the ayre is more grosse, doe altogether lye hid. And this is an error which I doe not so much blame in others, as I wonder at it in *Johannes de Benedictis*: that so great a Mathematician, as he is held to be, should be led away with so grosse an error. For the reason of this is altogether otherwise and cleane contrary. For, for that very cause that the ayre is more grosse and thicke, the Stars therefore doe appeare more, and greater. Which opinion of ours is confirmed; both out of principles of the Optickes, and also by the sense of it selfe, experience, and authority of learned writers.

For first, that the raies being refracted through a grosse *Medium*, and diffused as it were into certaine Canales, doe represent the image of the object greater then indeed it is, is plainly affirmed (and that according to the doctrine of the Optickes) by *Strabo* himselfe out of *Posidonius*. And that through *Peris-*
cills

cills or Spectacles, things appeare more, and greater then otherwise they would, is a thing well knowne to the moſt Ignorant. *Cleomedes* alſo ſaith, that the Sunne being ſeene by any in the bottome of a deepe Well, ſeemes greater, then when he is ſeene from above: and that by reaſon of the moyſtnes and groſſeneſſe of the ayre in the bottome of the Well. And if it were poſſible to ſee the Sunne through ſtone walles, or other ſolid bodies (as the old Poets fabulouſly report of *Lyncus*;) he would ſeeme much bigger then he is; as *Posidonius* rightly teacheth. And hence is it, (ſaith *Strabo*) that we ſee the Sunne alwayes greater, at his riſing and ſetting, eſpecially to thoſe that are at Sea. Yet we doe not ſay that he appeares ten times greater then he is, as it is reported he doth in *India*, out of the Excerpts of *Eteſias* his Indian Hiſtories: much leſſe that he ſeemes to be an hundred times greater then he is in other places, as he is feigned by *Artemidorus* to be at his ſetting, to thoſe that inhabit a Promontory in the outmoſt parts of *Spaine*, which he calls *Promontorium Sacrum*: but is juſtly taxed for the ſame by *Posidonius*. *Alfraganus* would have the cauſe of this to be, for that the vapours which are exhaled out of the earth, and elevated into the ayre, and ſo interpoſed betwixt our ſight and the Sunne at his riſing or ſetting, doe make him appeare greater then he is. The ſame is the opinion of *Strabo* and *Cleomedes* alſo, out of *Posidonius*: neither doth
this

this differ much from the opinion of the best of our Opticall writers. But of this enough.

There are also observed many Stars in the Southerne parts of the world : which because they could not be seene by our Artists in this parts of the world, we have therefore no certaine knowledge left us concerning the same. So in like manner, among those which we have hitherto spoken of, many of them cannot be seene by those that inhabit any whit neare the North Pole. But concerning those Stars that appeare about the South Pole of the world, I will here set you downe a very admirable story, which *Franciscus Patricius Senensis* relateth in the end of his *Novus Philosophia*, out of the Navigations of *Americus Vesputius*. And it is thus. *Caelum decentissime exornatur, &c.* The Heavens (saith he, meaning about the Antarctique Pole) is variously adorned with diverse Constellations, which cannot be seene here with us : among which I doe very well remember that I reckoned very neare twenty, which were as faire and bright as *Venus*, and *Jupiter* here with us. And a little after he saith. I was certaine therefore, that these Stars were of greater magnitude, then any man can conceive : and especially three *Canobi*, which I saw, and observed ; two whereof were very bright ones, but the third was somewhat obscure, and nothing like the rest.

And a little after he proceeds. But the Pole it selfe is encompassed about with three Stars,

Stars, which represent the figure of a right-angled Triangle : among which, that which is in the midst, is in circumference, 9. gr. and a halfe : and when these rise, there appears on the left hand of them another bright *Canobus* of notable magnitude.

And a little after he saith. After these there follow three other very faire Stars, the middlemost of which hath in Diameter 12. degrees and an halfe : and in the midst among these, there is seene another *Canobus*. After this there follow 6. other bright Stars, which excell all the other Stars in the eighth Sphere for brightnesse : the middlemost of them, having 32. gr. in Diameter. These Stars are accompanied by another great, but darker *Canobus* : all which Stars are observed in the Milky way.

To this he addeth out of *Corsalins* this that followeth. *Andreas Corsalins* also affirmeth, that there are two clouds, of a reasonable brightnesse, appearing neare the Pole ; betwixt which there is a Star distant from the Pole, about 11. gr. over which, he saith, there is seene a very admirable figure of a Crosse, standing in the midst of 5. Stars that compass it about, with some certaine others that move round about with it, being distant from the Pole, about 30. degrees : which are of so great brightnesse, as that no Signe in the Heavens may be compared with them.

And now that you have heard this so strange and admirable relation of the Stars about the

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Antarctique

Antarctique Pole, *Audistum admissi risum tenetis*? For *Vespuccius* hath here forged three *Canobi*, whereas *Ptolomy*, and all the Ancient Greekes never knew but one, and that is it which is placed in the sterne of the ship *Argo*. And here it is very well worth our noting, that *Patricius* (as farre as I am able to gather out of his writings) out of *Vespuccius* his ill expressed language, and by him worse understood, hath very excellently framed to himselfe a strange kinde of Star, that hath in apparent Diameter, 32. degrees: whereas the Diameter of the Sunne it selfe hardly attaineth to 32. minutes.

But those things which out of our owne certaine knowledge and experience in above a yeares voyage on Sea, in the yeares, 1591. and 1592. we have observed beyond the *Æquator*, and about the Southerne parts of the world, we will here set downe.

Now therefore there are but three Stars of the first magnitude t' at I could perceive, in all those parts, which are never seene here in *England*. All which notwithstanding *Ptolomy* saw, in *Alexandria* in *Egypt*. The first of these is that bright Star in the sterne of *Argo*, which they call *Canobus*. The second is in the end of *Eridanus*. The third is in the right foote of the *Centaur*. To which if you will adde for a fourth, that which is fixed in the *Centaur*s left knee, I shall not much stand against it. But other Stars of the first magnitude, then these which I have named, that part of the world

world cannot shew us. Neither is there to be found scarcely two or three at the most, of the second magnitude, but what *Ptolomy* had scene. And indeed there is no part of the whole Heavens, that hath so few Stars in it, and those of so small light, as this neare about the Antartique Pole: We had a sight also of those Clouds *Andreas Corsalius* speaks of, the one of them being almost twice or thrice as big as the other, and in colour, something like the *Via Lactea*, and neither of them very farre distant from the Pole. Our Mariners use to call them *Magellanes Clouds*. And we saw also that strange and admirable Crosse which he talkes of, which the *Spaniards* call *Cruzero*, and our Countymen, the *Cruisers*. And the Stars of which this Crosse consists, were not unknowne to *Ptolomy* also: for they are no other, then the brighter Stars which are in the *Centaurus* scete. All which things I did the more diligently and oftener observe, for that I remembred that I had read in *Cardan* also, strange relations of the wond'full magnitude of the Stars about the South Pole, not unlike the stories we have now alleadged out of *Patricius*.

PONT. The names of the Constellations of the Southerne Hemisphere as they have beene now lately observed, and named by the Portugals and others, are these. The South Triangle; the Crane; the Phoenix; the Water Serpent; the Dorado, or Gilthead fish, situated in the very Pole of the Ecliptique; the Chamleon

with the flie; the Flying Fish; the Bird of Paradise; the Peacocke; the naked Indian; the bird Toucan, or Brasilian Pye. All which are accurately portraited in the Globes set forth by Hondius. Among all these there are no Stars of the first magnitude, but of the 2. seven: of the 3. six: of the 4. thirty five: of the 5. fifty six: of the 6. eleven: with six unformed, and two cloudy Stars, besides the two cloudes themselves. Now the whole number of the Stars in this Southerne part, besides the cloudy ones, is 121. which being added to 1022. the whole summe will be 1143. Of which, 1022. were reckoned before by our Author, out of Ptolomy: onely there is a scruple cast in our way by those words of Pliny, in his lib. 2. cap 41. Patrocinator vastitas cœli, &c. And this opinion (saith he) is seconded also by the vastnesse and immensity of the Heavens. Which is distinguished into 72. Signes, all which are the resemblances either of living creatures, or other things, according as they have beene reduced into method and order by the skilfull in those Artes. Among which Constellations. they have observed 1600. Stars, all which are notable either in their effects or magnitude. Where we see that he accounteth the whole number of the Stars to be 1600 whereas Ptolomy after him acknowledged onely 1022. So likewise he reckoneth the Signes or Asterismes to be in all 72. which yet in Hipparchus, Eudoxus, and Ptolomies account, are but 48.

Scaliger in his Commentaries upon Manilius, pag. 67. that he might untie this knot, reads those words

words of Pliny thus. Patrocinatur vastitas
cœli, immensa altitudine, discreta in duo de
L. signa, &c. where for seventy two, hee would
have it to be wanting two : which is 48. the
just number reckoned by Ptolomy. But yet
the same doubt still remaines in the ensuing words,
where he maketh the whole number of the Stars
to be 1600.

I find also two other Signes added to the former
Southerne Constellations, which are Noah's
Dove, and the Phœnicopter. The first of
which containeth in it, 11 Starres : of which
there are two in the backe of it of the second mag-
nitude, which they call the Good messengers,
or bringers of good newes : and those in the right
wing are consecrated to the Appeased Deity, and
those in the left, to the Retiring of the waters in
the time of the Deluge.

The Phœnicopter we may call the Bittour.
Of this bird, Martiall hath an Epigram, lib. 13.

Dat mihi penna rubens nomen, sed lingua
gulosus

Nostra placet. Quid si garrula lingua foret ?

The Spaniards call it Flamengo : and it is
described with the wings spread abroad, and as it
were striking with his bill at the South Fish,
in that part where he boweth himselfe. This Aste-
risme consisteth of 13. Starres : of which, that
of the second magnitude in his head is called, the
Phœnicopters Eye : and it hath two other
Stars also of the same magnitude, one in his
backe, and the other in his left wing. And those
two which are in the middle of his necke, Paulus
Merula

Merula in his first booke of his Cosmography,
calleth his Collar or Chaine.

Lastly, wee are to take notice that the Indi-
ans call the South Pole, Dramasa: for so Pliny
testifieth in his lib. 6. cap. 19. Austrum Po-
lum Indi Dramasa vocant.



The



The third Part,

CHAP. I.

Of the Geographickall description of the Terrestriall Globe; and the parts of the world yet knowne.

D*ionysius Afer* in the beginning of his *Periegesis*, saith, that the whole Earth may be said to be, as it were, a certaine vast Iland, encompassed about on every side with the Ocean. The same was the opinion of *Homer* also before him, and of *Eratosthenes* (whom *Dionysius* is observed by *Eustathius*, his Scholiast, to follow in many things) as is witnessed by *Strabo*. The same is affirmed by *Mela* also after him. This vast Iland of the whole Earth they would have to be terminated on the North side, with the frozen Sea, which is called by *Dionysius*, *Mare Saturninum*, and *Mortuum*: on the East, with the Easterne Sea, which is also called *Mare Sericum*: on the South, with the Red Sea, (which *Ptolomy* calleth the Indian Sea) and the *Aethyopian*; and on the West, with the *Atlantick* Ocean. Out of this Ocean also,

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there

there are foure principall gulfes (as the Ancient Geographers conceived) which embosomed themselves into the maine land. Two of which derived their course out of the *Erythraean* or Red Sea, to wit, the *Persian* and *Arabian* gulfes. From the West, there is sent out of the *Atlanticke Ocean* a vast gulf, which is called the *Mediterranean* Sea. And out of the North, they would have the *Scythian Ocean* to send in the *Caspian Sea*, which is shut in almost on every side, with high craggy rockes; from whence the streames flow with such violence, that when they are come to the very fall, they cast forth their water so farre into the Sea, without so much as once touching upon the shore, that the ground is left dry and passeable for whole Armies under the bankes: the streames in the meane time being carried over their heads; as it is reported by *Eudoxus* in *Strabo*. This Sea both *Strabo*, *Pliny*, *Mela*, and *Solinus*, will have to come out of the *Scythian Ocean*, (as we have said) But this error of theirs besides the experience of these later times, is manifestly convinced by this one testimony of Antiquity: which is, that the water of this Sea is found to be fresh and sweet, as was first observed by *Alexander the Great*, and afterwards by *Pompey*, as *M. Varro* in *Solinus* testifieth, who at that time himselfe served under *Pompey* in his Warres. And this is the chiefe reason which *Polycleitus* in *Strabo* alleadged, for the prooffe of the same.

Now all this tract of land the Ancients divided

vided at firſt into two parts onely, namely, *Aſia*, and *Europe* : to which, ſucceeding times added a third, which they called *Africa*, and ſometimes alſo *Lybia*. And of theſe *Aſia* is the greateſt, *Africa* the next, but *Europe* the leaſt of all : according as *Ptolomy* determines it, in the 7. booke of his Geography.

Europe is divided on the Eaſt from *Aſia* by the *Ægean* Sea (which is now called the *Archipelago*) and the *Euxine* Sea ; which was at firſt (as *Strato* in *Strabo* thought) encompassed about on all ſides in manner of a great lake, till at laſt by the great acceſſion of other Rivers and waters, it ſo farre encreaſed, as that the bankes being unable to containe it, it violently made it's way into the *Propontis* and the *Helleſpont*. The *Euxine* Sea is now called *Mare Maggiore*. It is alſo bounded on the ſame ſide, by the lake of *Meotis* (now called *Mare delle zabacche*) the river *Tanaïs*, (commonly called *Don*) and the Meridian, which extends it ſelfe from thence to the *Scythian* or *Frozen* Sea. On all other ſides it is encompassed with the Sea. For toward the South it is divided from *Africa* by the Straits of *Gibraltar*, and part of the *Mediterranean* Sea. (The length of theſe Straits is according to *Strabo*, and *Pliny*, 120. furlongs : and the breadth of it, according to the ſame *Strabo*, 70. furlongs. But *Mela* would have it to be 10. miles, that is to ſay, 80. furlongs. *T. Livius*, and *Cornelius Nepos* make the latitude of it to be, in the broadest place,

place, 10. miles, or 80. furlongs; and where it is narrowest, 7. miles, or 56. furlongs. But *Turanus Gracula*, who as *Pliny* reports, was borne about those parts, accounted it to be from *Mellaria*, a Towne in *Spain*, unto that Promontory in *Africa*, which is called *Promontorium Album*, but 5. miles in all, that is, 40. furlongs. *Eratosthenes* was of opinion, that *Europe* was sometime joyned to the Continent of *Africa*. And it is reported by *Pliny*, that the inhabitants of those parts have a Tradition, that the *Isthmus*, or necke of the land by which *Europe* and *Africa* were joyned together, was cut through by *Hercules*.

Europe is terminated on the West with the Atlanticke Ocean: and on the North with the British, Germane, and frozen Seas.

PONT. This Northerne part of *Europe* began first to be discovered and knowne to the world, in the raigne, or rather through the meanes, and by the direction of Augustus Cæsar. For as *Pliny* saith, lib. 2. cap. 76. *Septentrionalis Oceanus majore ex parte navigatus est, &c.* The Northerne Ocean for the greatest part was first searched by Augustus Cæsar, who sent forth a Navy, which passing all along the Coast of Germany, came so farre as the Promontory of the *Cimbrians*, and thence passing on through a vast Sea, which they had onely heard of before, they went as far as the Coasts of *Scythia*. In which place *Pliny* meaneth those Sea expeditions, performed by *Tiberius*, and *Drusus Germanicus*: but especially that of *Drusus*, as may appeare by those words

words of Tacitus, where he saith thus, *Ipsium quinetiam Oceanum illa tentavimus, &c.* We left not the Ocean unattempted that way also, and it is a common fable, that Hercules Pillars are yet remaining; whether it be true indeed, that Hercules ever went so farre; or else that what ever Magnificent thing is any where to be found, we all conspire unanimously to honour him therein. Neither was there wanting courage for the attempt to Drusus Germanicus; onely the Ocean would not suffer it selfe, nor Hercules, to be farther enquired into. After this no man attempted it: and it was thought a greater paynt of reverence and religion, to believe the Actions of the gods, then to know them. Thus be.

Now before this time, all this tract of land lying toward the North, the Romans called *Novus Orbis*, *Ignotus Orbis*, the New and unknowne world: as I remember I have scene it, in a certaine Elegy of Albinovus upon the death of the same Drusus. And the Promontory of the *Cimbrians*, which Pliny speakes of, is now called *Scagen*, and is the most northerne poynt of *Denmarke*.

And as concerning these Pillars of Hercules, mentioned by Tacitus; *Hadrianus Iunius* who sometime saw these coasts, referreth the same to that high rocke or Promontory in *Scandinavia* (*Iunius* hath it *Noruegia*, but not rightly) which is at this day called *Col*, both by the Natives, and our Marriners also. For in this place they have a superstitious custome, that, as *Strabo* reports of the *Gaditan* Pillars, when any shippe had arrived there, as if they had attained an
end

end of their labours and travaile, they forthwith sacrificed to Hercules : in like manner in this place they have a custome, that if they have fresh-men that never sailed those Northerne Seas before, they have certaine Ceremonies with which they use to make them free of the Seas, (as I my selfe once saw done sailing by this Promontory) for they take and bind them to the mast of the shippe, and then taking the scoope and filling it with Sea water, they make as it were a Libation, powring it upon their heads, which done, they are forthwith exiated, and accounted free of the place. But whereas Iunius would have the word Col, to be onely corrupted from Columna, I much doubt whether he will have any more of his opinion. But of this place, as also of all this Northerne tract of land, I shall have a more convenient opportunity to speake elsewhere.

Africa is divided from Asia, according to Dionysius and Mela) by the river Nilus, and a Meridian drawne through it, to the Ethiopian Ocean. But Ptolomy would rather have its limits on this part to be the Arabian gulte (which he not so rightly calleth, the Red Sea, and a Meridian, which should be drawne from thence to the Mediterranean Sea, over that necke of land which lyeth betwixt the two Seas, and which joyneth Egypt to the Continent of Arabia and Indea. Neither doth he thinke it congruous, that Egypt should be divided into two parts, one whereof should be reckoned to Africke, and the other to Asia : which must needs be, if the river Nilus be set
for

for the bounds of the same. Neither doth *Strabo* conceive this to be any whit improper, since that the length of this *Isthmus*, which divideth the two Seas, is not above 1000. furlongs. And he seemeth to have said very rightly, that it is not above a 1000. furlongs. For however *Posidonius* reckoneth it to be very neere 1500. furlongs : yet *Pliny* would have it to be no more then 115. miles, that is to say, 920. furlongs. And *Strabo* also reckoneth the distance betwixt *Pelusium* and the *Heroes* City, which is situate close by the highest part of the Arabian Gulfe, to be but 900. furlongs. But if we will give any credit to *Plutarch*, at the narrowest part of the *Isthmus*, the two Seas will be found to be distant not above 300. furlongs. And that, (when *Anthony* was overthrowne by *Augustus* in a Sea fight, and all his forces cleane broken,) *Cleopatra*, seeking to avoid the servitude of the Romans, went about to transport her navie this way over the firme land, that so she might find some new place of habitation, as farre remote from the Romans as she might : as it is reported by the same Author, in the life of *Anthony*. But what should move *Copernicus*, in his 1. booke 3. Chap. to say, that these two Seas are scarcely 15. furlongs distant ; I cannot conjecture ; unlesse I should thinke the place to be corrupted, through the negligence of the Transcribers, or Printers. And yet I could wish, that this, (though it be a very great one,) were all the errours that were to bee found in the writings

ings of that most excellent man.

This *Isthmus*, as *Eratosthenes* conceived, was anciently covered all over with waters, till such time as the Atlantick Ocean had intercourse with the Mediterranean : And some of the old Grammarians, Scoliaſts on *Homer*, doe affirme, (as *Strabo* testiſieth) that it was this way, that *Menelaus* in *Homer*, ſailed to the *Aethyopians*. I will therefore here ſet downe ſome few things, which may ſeeme to make for the confirmation of this relation, (whether you will call it an *History*, or rather a *Fable*, or *Conjecture*) of *Eratosthenes*.

First therefore that *Egypt*, (if not all of it, yet at leaſt that part of it, which is ſituated beneath *Delta*, and is called *Egyptus Inferior*, the lower *Egypt*, and is accounted to be the gift of *Nilus* (or rather of the Sea) was made by the aggeſtion and gathering together of mud and ſand ; was the conjecture of *Herodotus*, long before *Strabo*. In like manner, that the Iland *Pharos*, which in *Plinies* time was joyned to *Alexandria* by a bridge, as himſelfe testiſieth, lib. 5. cap. 31. (and therefore for this reaſon may ſeeme to have beene called a *Peninſula* by *Strabo*) was anciently diſtant from *Egypt* a whole day and nights ſaile, is reported both by *Pliny* and *Solinus*, out of *Homer*. And this is the reaſon, as *Strabo* conjectures, that *Homer*, (whereas he makes often mention of *Thebes* in *Egypt*) yet ſpeakes not one word of *Memphis* : and that either becauſe at that time it was a very ſmall place,
or

or else perhaps was not as yet in being, the land being in *Homers* time covered all over with water, where *Memphis* was afterward built. And this seemes also to be confirmed by the great depression and lownesse of the intermediate shore betwixt the two Seas; which is so great, that when *Sesostris* first had an intent of cutting a channell betwixt the two Seas, as was afterward intended also by *Darius*, and lastly, by *Ptolomy*; they were all forced for this reason to desist from their enterprize. And indeed *Strabo* reports, that himselfe saw the *Egyptian* shore in his time all overflowed, beyond the Mountaine *Casius*. Besides, the great retireing of the waters at an ebbe, as well in the Arabian gulf, as in the Persian, seeme somewhat to confirme this conjecture of *Eratosthenes*. For the tides withdraw themselves so farre backe in the Arabian gulf: that *Julius Scaliger* makes mention of some Cavillers, that for this very reason went about to derogate from the miraculous passage of the Children of *Israel* for the space of above 600. miles through the red Sea: as if they had watched their time, when the tide gave way: and that when it returned againe, the *Egyptians* were overtaken therewith and all drowned.

PONT. This Sea is alwayes rendred by the *Septuagint*, *Erythraum*; and by *St. Hierom*, *Rubrum*: but the *Hebrew* text is selfe, understanding this gulf of the Sea (which is called also by *Ptolomy*, *Sinus Arabicus*), calleth it *Mare Suph*;

Suph; which is as much as to say, More-algofum, seu caricofum, because it bringeth forth great store of Alga, and Sea weedes. Which is observed also by Pliny, lib. 13. cap. 25. where he saith. Nascuntur & in mari frutices, &c. There are also bred shrubs in the Sea: and in our Sea, little trees also. For the Red Sea, and all the Easterne Ocean is full of trees. For no other language hath a proper word to expresse that which the Greekes call $\phi\upsilon\chi\alpha$ because that Alga is more usually taken for the name of an hearbe, but in this place it signifieth a shrub. Thus Pliny. You may also see Strabo, lib. 16. That place which the Author citeth out of Scaliger, is in his 35. Exercitation against Cardan. And I thinke it not amisse to heare him speakeing in his owne words, that so it may appeare what his judgement is of that which is objected by those Cavillers. His words are these. In plaga Indica fecundum Gangis atque Indi fauces magnus est aestus, &c. About the coasts of India (saith he) where the Rivers Ganges and Indus disburthen themselves into the Sea, there are very high tides: So likewise in the Red Sea they are so great, as that the contemners of Holy Writ have impiously forged, that Moses, when he led the Israelites out of Egypt, tooke the opportunity of the waters retiring after the tide. Which notwithstanding could not possible be, because that as farre as Sues, which is situated in the innermost corner of the gulf, the Sea covereth the very shore; neither, when it ebbeth, doth it ever leave the ground so bare, as that the lower parts, through which the
Israelites

Israclites passed, should be free from passage on foote.

And it is reported by *Pliny*, that *Numenius*, Generall to *Antiochus*; fighting against the Persians, neare the mouth of the Persian gulfe, not farre from the Promontory called *Maca-vum*, got the victory of them twice in one day, first by a Sea combat; and afterward (the waters having left the place dry) on horsebacke: as it is related by him in his 6. booke, 28. cap.

And thus much concerning *Eratosthenes* his conjecture. Let us now returne to the bounds of *Africa*. Which is divided (as we have already said) on the East from *Asia*, by a Meridian drawne through the Arabian gulfe to the Mediterranean Sea. On all other sides it is encompassed about with the Sea: as on the West, with the Atlanticke; on the South with the *Ethiopian* Ocean: and on the North, by the Mediterranean, which is also the Southerne bound of *Europe*.

Now as concerning *Ptolomies* ignorance of the Southerne parts of *Africa*, making it a continent and contiguous to *Asia* by a certaine unknowne land, which he would have to encompassse about the South side of the *Indian* Sea and the *Ethiopian* gulfe: if it be not sufficiently evinced out of the relations of the Ancients; as namely, of *Herodorus*, who reporteth, that certaine men were sent forth by *Darius* by Sea, who sailed about all this tract: nor yet of *Heracides Ponticus*, who relates a

story of a certaine Magician that came from *Gelon*, who said that he had compassed about all these coasts : (because *Pofidonius* accounteth not these relations of credit enough to conclude any thing against *Polybius* : neither doth he approve of that story of one *Endemus Cyzicenus*, reported by *Strabo*, *Pliny*, and *Mela*, out of *Cornelius Nepos*, an Author of very good esteeme, (and that because *Strabo* thought this relation to deserve no more credit, then those fabulous narrations of *Pythæus*, *Euemerus*, and *Antiphanes* :) nor lastly, those traditions of King *Juba* concerning the same matter, related by *Solinus* : Howsoever, I say, that these Traditions of the Ancients doe not convince *Ptolomy* of ignorance ; yet certainly the late navigations of the Portugals most evidently demonstrate the same, who touching upon the outmost point of all *Africa*, which they now call, the *Cape of good hope*, passe on as farre as the East Indies. I shall not in the meane time neede to speake at all of that other story w^{ch} *Pliny* hath : how that at what time *C. Cesar*, Sonne to *Augustus*, was Proconsul in Arabia, there were certaine Ensignes found in the Arabian gulf, which were knowne to be some of those, that were cast away in a shipwracke of the Spanish Navy : and that *Carthage* at that time being in her height of power, *Hanno* a Carthaginian sailed about from *Gades*, as farre as *Arabia*, who also afterward himselfe wrote the story of that navigation.

Asia lyeth Eastward both from *Europa* and *Africa*, and is divided from them, by these bounds and limits which we have already set downe. On all other parts it is kept in by the Ocean: on the North, by the *Hyperborean* or Frozen Sea: on the East, by the *Tartarian* and Easterne Ocean: on the South, by the Indian and Red Sea. But *Ptolomy* would have the Northerne parts of *Asia*, as also of *Europe*, to be encompassed, not with any Sea, but with a certaine unknowne land: which is still the opinion of some of our later writers, who thinke that Countrey, which we call *Groenland*, to be a part of the Indian Continent. But we have very good reason to suspect the truth of this their opinion; since that so many Sea-voyages of our owne country-men, who have gone farre within the Arcticke circle, beyond the utmost parts of *Norway*, and into that cold frozen channell, that divides *Nova Zemla* from *Russia*: doe sufficiently testifie, that all those parts are encompassed with the Sea. Not to speake any thing of that which *Mela* alleadgeth out of *Cornelius Nepos*, how that when *L. Metellus Celer* was Proconsul in *Gallia*, there were presented him by the King of *Suevia*, certaine Indians, who having bene severed by force of tempests from the Indian shore, had bene brought about by the violence of the windes as farre as *Germany*. Neither will I here mention that other relation of *Parrocles*, in *Strabo*: who affirmed, that it was possible to

saile to India, all along the Sea shore a great deale more Northward then the *Baltian*, *Hircania*, and the *Caspian* Sea : now *Parricles* was made governour of these places. Nor lastly, that which *Pliny* himselfe reporteth, how that all this Easterne coast, from India as farre as to the *Caspian* Sea, was sailed through by the Macedonian Armies, in the raigne of *Seleuchus* and *Antiochus*.

Concerning the quantity of the Earth which was inhabited, there was great diversity of opinions among the Ancient. *Ptolomy* defined the longitude of it to be, from West to East, beginning at the Meridian which passeth through the fortunate Ilands, and ending at that which is drawne through the Metropolis of the *Sine*, or Chineans country. So that it should containe halfe the *Aequator*, which is 180. degrees, and 12. *Aequinoctiall* houres, or 90000. furlongs measured by the *Aequator*. And he determined the bounds of the latitude to be, toward the South, that Parallel which lyeth 16. gr. 25. m. Southward of the *Aequator* : and the Northerne limits he made that Parallel, which passeth through *Thule* or Iseland, being distant from the *Aequinoctiall* 63. degrees. So that the whole latitude of it contained in all, 79. gr. 25. m. or 80. whole degrees, which is neare upon 40000. furlongs. The extent of it therefore from East to West, is longer, then it is from North to South, under the *Aequinoctiall* something then more by halfe as much, and under the
the

the most Northerne Parallel, almost by a fiftieth part. Good reason therefore had the Ancient Geographers, as *Ptolomy* conceives in his *lib. 1. cap. 6. Geograph.* to call the extent of it from West to East, the Longitude of it; and from North to South, the Latitude. *Strabo* also acknowledgeth the Latitude, with *Ptolomy*, to be 180. degrees in the *Æquator*, as likewise *Hipparchus* doth also: notwithstanding there is some difference betwixt them, in the number of the furlongs. For these last have set downe the Longitude to be of 126000. furlongs under the *Æquator*: herein following *Eratoſthenes*, who reckoneth 700. furlongs to a degree. But *Strabo* maketh the Latitude a great deale lesse; that is, something lesse then 30000. furlongs: and hee boundeth it on the South, with the Parallel drawne through *Cinnamomifera*, which is distant Northward from the *Æquator* 8800. furlongs: and on the North with that Parallel, which passeth through those parts which are 4000. furlongs, or thereabout, more Northward then *Britaine*. And this Parallel that passeth through the Region called *Cinnamomifera*, *Strabo* makes to be more Southward then *Taprobane*, or at least to passe through the most Southerne parts of the same. But herein he betrayeth his own notable ignorance: for as much as the most Southerne part of this Island is extended farre beyond the *Æquator*; as both *Ptolomy* affirmeth in his *Geography, lib. 7. cap. 4.* and is further confirmed by the late Navigations of the *Portugals.*

gals. But *Dionysius Afer* is much farther out of the way then so: for he placeth *Taprobani* under the Tropicke of *Cancer*.

And these were the bounds wherewith the Ancient Geographers terminated the then inhabited parts of the world. But in these latter times of ours, by the industry at Sea, both of the Spaniards, English, and others, the Maritime coasts of Africa have beene more thoroughly discovered, to above 35. gr. of Southerne Latitude: and the Northerne limits of Europe have now beene searched into, as farre as the 73. degree of Northerne Latitude, farre within the Arcticke circle: besides all that which hath at length beene discovered in the New world, beyond the hope or opinion of any of the Ancients, the name of it being not so much as knowne to them.

America, which for it's spaciousnesse may well be called, The other world, extending it selfe beyond 52. gr. of Southerne Latitude, is there bounded with the Straits of Magellane: and toward the North it runneth farre within the Arcticke circle: on which side also that it is bounded by the Sea, the many Navigations of our Country-men into those parts, doe give strong arguments of hope. I shal not here speak of those Sea coasts, which are beyond that Sea that encompasseth about the most Northerne parts of Europe and Asia; as having been but only seene as farre off as yet, and not thoroughly discovered. Nor yet those other, which are more Southerne then the Indian and Red Seas:

Seas. Which as yet we have not any experience to the contrary, but that wee may believe to bee one continent with thoſe other Southerne Lands, that lye beyond the Straits of Magellane.

Europe (whether ſo called from *Europa Tyria*, daughter to *Agenor*, as ſome thinke; or *Phanix*, as *Herodotus* will have it; or elſe from *Europa* a Sea Nymph, according to the opinion of *Hippias* in *Euſtathius*; or elſe from *Europus*, as *Nicias* in the ſame *Euſtathius* would have it to be;) containeth in it theſe principall regions: to wit, Spaine, France, Italy, Germany, Bohemia, Pruſſia, Rhætia, Livonia, Sclavonia, Greece, Hungary, Polonia, Moſcovia or Ruſſia, Norway, Sweden, and Denmarke. To theſe wee may adde the principall Iſlands, as namely thoſe of great Britaine, the chiefe of which is England, and Scotland, ennobled chiefly by being united to the Engliſh Crowne: as alſo Ireland, which is in like manner ſubject to the ſame. Beſides the Azores, and many other Iſlands ſcattered up and downe in the *Mediterranean Sea*, as Sicily, Sardinia, Crete, &c.

PONT. In *Europe* theſe things are chiefly observable. 1. The moſt famous Monarchies which are in it; as namely the Emperour of Germany, the Kings of Spaine, France, Great Britaine, Denmarke, Sweabland, Polonia, and Moſcovia. To which we may adde the Pope of Rome, who though he uſurpe not the title of a King, yet is his power no whit inferiour to theirs: as alſo the great

I. 4. . Turke.

Turke, who at this day possesseth a great part of Europe also. 2. The principall hills, which are the Alpes dividing Italy from Germany and France; and also the Pyrenean Hills, severing Spaine from France. 3. The notable rivers, as the Danow, the Rheine, the Elue, the Weisell, Boristhenes, and Tanais, now called Don. To which we may adde the river Tagus in Spaine, the Rhone and Guaronne in France, and Thames in England. Lastly, the principall commodities in Europe, are Gold, Silver, Tinne, Lead, Iron, Oyle, all kind of graine, Flaxe, Wooll, Salt, &c.

Africa (whether it be so called from Apher, one of Hercules his companions, in his expedition against Gerion; according to Eusebius: or else from one Iphricus, a certaine King of the Arabians; whence also it is called in Arabicke *Iphricia*, as Iohannes Leo testifieth; or lastly from its scorching heat, as if it should be called *ἀψείκη* quasi sine frigore, as some are pleased to derive it;) hath in it these principall regions. First of all next to the Straits of Gibraltar, (anciently called *Fretum Gaditanum*) there lyeth *Barbary*, heretofore called *Mauritania*; which containeth in it the kingdomes of *Morocco*, *Fez*, *Algier*, and *Tunis*. Next to *Barbary* lyeth *Egypt*, which also bordereth upon the *Mediterranean* Sea. Now within *Barbary* toward the continent, there lyeth *Biledulgerid*, known to the Ancients by the name of *Namidia*. The 3^d is that part which is called by the Greekes and Latines *Libya*: but the Arabians name it *Sarra*. After this followes the country

try of the Negroes, so called because they border upon the River *Niger*, or else from their colour. This Country is now usually called *Senaga*: and it hath in it many petty kingdomes, as namely, *Gualata*, *Guinea*, *Melli*, *Tombutum*, *Gagos*, *Guberis*, *Agades*, *Canos*, *Casena*, *Zegzega*, *Zanfaran*, *Burnum*, *Gaoga*, *Nubia*, &c. Next to these is the spacious Territory of the King of the *Ethiopians*, (who is also called *Pretegiari*, and corruptly *Prester John*) which kingdome is famous for the long continuance of the Christian Religion in it, which hath been kept amongst them in a continuall succession, ever since the Apostles time. These Christians are commonly called *Abyssines*, but more rightly *Habassines*, as *Arias Montanus* observeth in the *Itinerary of Benjamin Tudelensis*. Their dominion was anciently extended very farre through *Asia* also. These have bordering on the West some few obscure kingdomes, as *Manicongo*, and *D'Angola*: and toward the East and South, *Melinde*, *Quiloa*, *Mozambique*, and *Benamatapa*. The chiefe Islands that are situate neare it, are *Madagascur*, the *Canary Islands*, the *Isles of Cape Verd*, and *S. Thomas Island*, lying directly under the *Equator*.

PONT. Africa hath these things in it considerable. 1. It is greater then Europe, but lesse then Asia, and lesse inhabited, and civilized then either. 2. It is bounded with the Sea on all sides, save only where it is conterminat with Asia. 3. The principall regions of it, are, *Mauritania*, *Numidia*,

Numidia, Libya, Cyrenaica, Egypt, and Ethiopia. 4. The most famous kingdoms are these, Morocco, Fez, Algier, and also that of Prester John, or Ethiopia. 5. The greatest Mountaines are, Atlas, and that other whence Nilus springeth. 6. The principall rivers are Niger, and Nilus, which is accounted to be the greatest in the world, and as Diodorus Siculus affirmeth, encompasseth 700. Islands. 7. The principal Merchandise of Africke, is Ivory, Civer, Gold, Cotton Wooll, Jewels, and certaine kinds of spices, as also Salt, Lions, Camels, &c.

Asia (so called from *Asia*, the mother of *Prometheus*, as the common received opinion is; or else from a certaine Hero of that name, as *Hippias* in *Eustathius* will have it, at this day wholly in subjection to the great Turke, and the Persian, as farre as to the East Indies, the greatest part whereof is under the Kings of *China* and *Pegu*. But the more Northerne parts of *Asia* are possessed by the *Muscovites*, *Tartarians*, and those that inhabit the region of *Cathia*. The principall Islands appertaining unto it, are *Cyprus*, and *Rhodes* in the *Mediterranean*: and on the South side, *Sumatra*, *Zeilam*, *Iava Major* and *Minor*, the *Moluccan* and *Philippine* Islands, beside *Borneo*, and almost an infinite company of others. And on the East of it there lye the *Japonian* Islands.

PONT. That it ought to be written *Sinx*, not *Chinx*, as our Author in this place, and commonly all other writers use to doe, appeareth manifestly out of *Ptolomy*, who alwayes calleth them

them Sinæ. The eight Table also of Asia in Ptolomyes Geography, placeth the Scythians called Cathæ, (which our Author calleth the region of Cathaia,) betwixt the mountaines Imavus and Emodus : and the region of the Sinæans a part of it beyond the same Emodus and Ottorocara, which are hills in the Countrey of the Seres, and looking towards the Southeast. So that I cannot but wonder that Matthæus Riccius a Jesuite, in his Sinæan expedition should take so much paines to prove, that the Kingdome of Cathaia, and of the Sinæans is all one. But it were easie, by other and those more proper arguments, and testimonies, (were this place convenient) to prove the contrary to this his assertion.

Now as concerning Asia, these things occurre in it worth our observation. 1. That it is twofold, Asia Minor, and Major. 2. Asia Minor, or the lesser Asia, is bounded on the East by the Euxine Sea; on the South by the river Euphrates; on the West by the Mediterranean; on the North by the Ægean Sea. 3. The principall countries it contained anciently, were these : Cilicia, Pamphilia, Caria, Lycia, Ionia, Lydia, Æolia, Mysia, Bithynia, Paphlagonia, Cappadocia, Galatia, Lycaonia, and Pisidia. 4. To the greater Asia these regions appertained : Syria, Armenia, Chaldaea, Arabia, Persia, Tartaria, Hircania, Parthia, and India. 5. In both of them there are settled at this day these Empires ; namely, the Turkish, Persian, Tartarian, Indian, and Sinensian or Chinean. 6. The chiefe hills of note in it, are Taurus, Caucasus, and Imaus. 7. The principall

principall rivers, Euphrates Ganges, and Indus. 8. Their chiefeſt trafficke is, Gold, Pearle, Jewells, all kinde of Spices, Muske, Frankincense, Balsame, Amber, Silkes, Ivory, and Elephants.

America, (so called from *Americus Vesputius*, who first discovering it, gave it both name and bounds,) is terminated on the East side, (on which it lookes toward *Europe* and *Africa*) by the *Atlanticke* Ocean: on the West with the Sea which they call, *del Zur*, or the South Sea: on the South it is bounded with the Straits of *Magellane*. But as for the Northern parts of it, they are not yet thoroughly discovered, or the limits thereof knowne: notwithstanding the many adventures by Sea of our Countreymen, Mr. *Martin Frobiſher*, and Mr. *John Davis*, have given strong arguments of hope, that it is on that side bounded by the frozen Sea. It containeth in it these principall regions. First on the North, that countrey which the *Spaniards* call, *Tierra de Labrador*: after which followeth that which they call, *Baccalearum Regio*: then *Nova Francia*: after this *Virginia*; then *Florida*: next to this, *Nova Hispania*, famous especially for the City *Mexico*, and last of all the Kingdomes of *Brasilia* and *Peru*, which are the most Southern parts of all. There are also many adjacent Islands: most of which lye in the Bay of *Mexico*, eastward from *America*: the most notable of which are *Cuba*, and *Hispaniola*, besides many other of lesse note.

There

There are alſo many other parts of the world, not yet thoroughly knowne or diſcovered, as namely thoſe Southerne coaſts wherein ſtands *Nova Guinea* lying beyond the Indian Sea, which whether it be an Iſland, or elſe a part of the maine Continent, is not yet diſcovered : and likewiſe that other tract of the Southerne unknowne Continent, which is called *Magellonica* : as alſo thoſe Northerne parts of *Europe*, *Aſia*, and *America*, which have beene but lately detected by many of our Engliſh Navigators, but not as yet fully ſearched into.

CHAP. II.

Of the Circumference of the Earth, or of a Greater Circle : and of the Meaſure of a Degree.

IT remaineth now that we ſpeake ſomewhat of the circumference of the Earth, or of the greateſt circle in it; the knowledge whereof is very neceſſary, both for the ſtudy of *Geography*, as alſo for the eaſier attaining to the Art of Navigation. And therefore, I hope, I ſhall not ſeeme impertinent, if I inſiſt ſomething the longer on this argument : eſpecially ſeeing that there is great diverſity of opinion among the moſt learned Authors that are extant, concerning this matter; in ſo much that it is not yet determined, which of them we are to follow.

Ariſtotle

Aristotle in the end of his 2^d. booke de *Celestibus*, affirms (and that according to the doctrine of the Mathematicians, as himselfe saith) that the circumference of the Earth is 40000. furlongs. *Cleomedes lib. 1.* reckons it to be 30000. for he saith, that the Verticall Points of *Lysmachia* and *Syene*, were observed by Sciometricall Instruments, to be distant from each other the 15th part of the same *Ameridian*. Now the distance betweene these two places hee sets downe to bee 20000. furlongs : So that if 20000. bee multiplied by 15. the whole will arise to 300000. *Eratosthenes* (if we may believe *Strabo*, *Vitruvius*, *Pliny*, and *Censorinus*) would have the whole compasse of the Earth to containe 252000. furlongs. To which number *Hipparchus*, as *Pliny* testifieth, added very neare 25000. more. Yet *Strabo* as well in the end of his 2^d. booke of his Geography, as elswhere, affirmeth, that he used the same measure that *Eratosthenes* did : where he saith, that according to the opinion of *Hipparchus*, the whole quantity of the Earth containeth 252000. furlongs ; which was the measure delivered also by *Eratosthenes*. Which opinion of *Eratosthenes* is seconded also by that fabulous relation of *Dionysiodorus*, recorded by *Pliny*, lib. 2. cap. ult. where he saith, that there was found, in the Sepulchre of *Dionysiodorus*, an Epistle written to the gods ; wherein was testified, that the Semidiameter of the Earth contained 4200. furlongs. Which number being multiplied by 6. the Product will bee 252000.

Cleomedes relating the observations of *Eratosthenes*, and *Posidonius*, maketh it to be somewhat lesse, and that according to the doctrine of *Eratosthenes*: to wit, 250000. furlongs. For he placeth *Syene* and *Alexandria* under the same *Meridian*. Now *Syene* being situate directly under the Tropicke of *Cancer*, the Sun being then in the Summer Solstice, the *Gnomons* cast no shadow at all. For confirmation of which, the experiment was made, by digging a deepe Well, which at that time of the yeare was wholly enlightned on every part: as it is reported both by *Pliny*, and also by *Strabo* before him. But at *Alexandria*, when the Sunne is in the Summer Tropicke, the *Gnomon* is observed to cast a shadow to the fiftieth part of the circumference, on which it is erected to right angles, so that the top of the same, is the center of the circumference. Now the distance betwixt *Syene* and *Alexandria* is commonly set downe by *Eratosthenes*, *Pliny*, and *Strabo*, to be 5000. furlongs. If therefore 5000 be multiplied by 50. the whole will arise to 250000. which is the number of furlongs assigned to the circumference of the whole earth by *Eratosthenes*. *Posidonius*, proceeding after another method, though not unlike this, labours to prove the whole circuit of the Earth to containe 240000 furlongs. And first hee taketh for granted (which is also acknowledged by *Ptolomy*, lib. 5. cap. 3. *Almagest*.) that *Rhodes* and *Alexandria* are situate under the same *Meridian*. Now that bright Star in the sterne of *Argo*, (which they

they call *Canobus*, and which never appeareth in Greece, which seemes to be the reason why *Aratus* maketh no mention of it :) first beginneth to appeare above the Horizon at *Rhodes* : but it doth but *stringere Horizontem*, just touch the Horizon, and so upon the least circumvolution of the heavens setteth againe : or else, as *Proclus* saith, is very hardly seene, unlesse it be from some eminent place. But when you are at *Alexandria*, you may see it very cleare above the Horizon. For when it is in the *Meridian*, that is, at the highest elevation above the Horizon : it is elevated above the Horizon about the fourth part of a Signe : that is to say, the fortie eighth part of the *Meridian* that passeth through *Rhodes* and *Alexandria*. The same is affirmed also by *Proclus*, if you read him thus : *Canobum in Alexandria conspicue cerni, quarta circiter Signi portione supra Horizontem extante* : as it ought to be ; and not as it is corruptly read, in *Alexandria prorsus non cerni*. It is not seene at all : in stead of, It is seene very plainly : *αφανὲς* being crept into the text, perhaps in stead of *εὐφανὲς*. Now the distance betwixt *Rhodes* and *Alexandria* is set downe both by him, and *Pliny*, to bee 5000. furlongs : which being multiplied by forty eight, the product will be 240000. the number of furlongs agreeing to the measure of the Earths circumference, according to the opinion of *Posidonius*.

Ptolomy every where in his *Geography*, as also *Marinus Tyrius* before him, have allowed but

but 500. furlongs to a degree in the greatest circle on the earth, of which the whole circumference containeth 360. so that the whole compasse of the Earth, after this account, containeth but 180000. furlongs. And yet *Strabo* affirms in his *lib. 2. Geograph.* that this measure of the Earths circumference set downe by *Ptolomy*, was both received by the Ancients, and also approved by *Posidonius* himselfe.

So great is the difference of opinions, concerning the compasse of the Earth : and yet is every one of these opinions grounded on the authority of great men. In this so great diversity therefore, it is doubtfull whom we should follow. And if you should desire to know the cause of all these dissensions ; even that also is altogether as uncertaine. *Nonius*, and *Pencerus* would perswade us, that certainly the furlongs they used were not of the same quantity. *Maurolycus*, and *Philander* conceive the difference of furlongs to rise out of the diverse measure of Pases. And therefore *Maurolycus* takes great paines to reconcile them ; but in vaine : for they seeme not capable of any reconciliation. They tell us of diverse kinds of Pases in use among the Ancients. It is true ; wee assent to them herein : but withall desire to heare of some diversities of furlongs also, or at least, of feet. The Greekes (as I conceive) measured not their furlongs by Pases ; but by feet, or rather *ταῖς ὀρχαῖς*. Now *ὀρχα* is the measure of the extension of both the hands, together with the breast betwixt, containing

sixe feet, which we commonly call a fadome, and is a measure in familiar use with our Mariners, in sounding the depth of the Sea, or other waters. This word notwithstanding is translated by many, a Pase: but how rightly, I leave it to learned men to judge. *Xylander* in his translation of *Strabo*, alwayes rendereth it, an Ell. In like manner a furlong is defined by *Herodotus*, a very ancient Greeke Author, to consist of 600. feet: the same also is affirmed by *Suidas*; by much later then hee. Yet *Hermes Mechanicus* (or at the least his Scholiast) one, as I conceive, of the lowest ranke of Ancient Writers,) will have a furlong to containe 100. fadomes; a fadome foure Cubits: a Cubit a foot and a halfe, or twenty foure digits: But you will say perhaps, that *Censorinus* proposeth three severall kindes of furlongs: the first of which is the *Italian*, consisting of 625. feet: which he would have us understand to be that which is commonly used in measuring the Earth. The second is the *Olympian*: containing 600. feet: and the third and last is the *Pythean*, consisting of 1000. feet. But to let passe this later, if wee doe but looke more nearely into the matter, we shall find the *Italian* and *Olympian* furlongs, howsoever they differ in names, yet to be no other but the selfe same thing. For the *Italian* furlong, which containeth 625. Romane feete, (according as *Pliny* testifieth, in his second booke and twentieth Chapter) will bee found to be equall to the *Olympian*, consisting of 600. Grecian

feet

feete. For 600. Grecian feet, are equall to 625. Romane: for as much as the Grecian foote exceeds the Romane by a twenty fourth part: as much as is the difference betwixt 600. and 625.

Amongst these so great diversities of opinions, let us give our conjecture also, both what may be the cause of so great disagreement, and also which of them we may most safely follow. We will therefore passe by *Aristotle*, whose assertion is only defended by a great name. And for *Cleomedes* his opinion, of the Earths being in compasse 200000. furlongs, we should scarce vouchsafe to mention it, but that *Archimedes* also had taken notice of the same, as of a position not altogether disallowed in his time. Let us therefore examine *Eratosthenes*, and *Posidonius*, whose opinions seeme to be grounded on more certaine foundations. The cause therefore of their disagreement I conceive to bee, in that neither of them had measured exactly the distances of those places which they layd downe to worke on, but tooke them upon trust; from the common received report of Travailers: save only that of the two, *Posidonius* is the more extravagant. Whereas on the contrary *Ptolomy* grounded his opinion on the distances of places exactly measured, as himselfe affirmeth; when he saith: That the latitude of the knowne parts of the world is 79. degrees, and 45. minutes. Or supposing it to be full 80. degrees; it will then containe 40000. furlongs, allowing for every degree

five hundred furlongs : as by measuring the distances of places exactly, wee have found it to be.

But *Eratosthenes* is much taxed by *Hipparchus* for his strange mistakes and grosse ignorance in setting downe the distances of places : as *Strabo* testifieth in his first booke. For hee reckons betwixt *Alexandria* and *Carthage* above 13000. furlongs, whereas (saith *Strabo*) it is not above 9000. So likewise *Posidonius* is to bee blamed, for setting downe the distance betwixt *Rhodes* and *Alexandria* to bee 5000. furlongs, and that from the relation of Mariners, whereas some of them would have it to bee but 4000. and others 5000. as *Eratosthenes* confesseth in *Strabo* : but addeth moreover, that hee himselfe had found by Sciotericall instruments, that it was but 3750. And *Strabo* would have it to bee something lesse then that, namely 3640. furlongs. So that hence wee may safely conclude, that *Ptolomies* opinion, being grounded upon the more exact and accurate dimensions of distances, (as himselfe professeth,) must necessarily come nearer the truth then the rest.

But *Franciscus Maurolycus*, Abbat of *Messava*, whiles he goes about to defend *Posidonius* against *Ptolomy*, is overtaken himselfe in an errour, before hee is aware. For he suspecteth the truth of *Ptolomies* assignment of the latitude of *Rhodes*, which he sets downe to be thirty sixe degrees. And hee adverti-

sett

seth us, that certainly the numbers in his Geographick tables are corrupted: which, we confesse, is most certaine. But in the meane time let us see how he proves them to be so, in this latitude of *Rhodes*. *Posidonius* (saith he) out of his owne observations, setteth downe the latitude of it to bee thirtie eight degrees and an halfe: unlesse that *Ptol* my bee but also in designing the latitude of *Alexandria*; which *Maurolycus* thinkes cannot possibly be. But we affirme on the contrary side, that *Ptolomy* himselfe is against this latitude, not onely in his Geographick bookes, but also in diverse places throughout the *Almagest* also, and especially in the *lib. 2. cap. 6.* where he setteth downe the same latitude for *Rhodes*, that he hath in his Geography: adding moreover the quantity of the longest day, and also what manner of shadowes the *Gnomons* cast, both when the Sun is in the *Aequinoctiall*, as also in the *Tropickes*: all which doe plainly prove the same. He also very often hath the same latitude of it in his *Planisphere*: unlesse you will say, that either *Masses* the *Arabian*, in translating it into *Arabicke*, or else *Rodolphus Brungenfis*, who translated the same againe out of *Arabicke* into *Latine*, have deceived us. Hitherto therefore we stand on equall termes. But he proceeds, and saith, that this opinion of *Posidonius* is favoured also by *Proclus*, and the observations of *Eudoxus Cnidius* delivered by *Strabo*. Let us therefore see what all this is. *Posidonius*: (saith *Strabo*) reports, that himselfe being

sometime in a City distant from the *Gadirane* Straits 400. furlongs, saw from the top of an high house a certaine Starre, which he tooke to bee *Canobus* : and those that went thence more Southward from *Spaine*, confesse that they saw it also plainely. Now the Tower *Cnidus*, out of which *Eudoxus* is said to have seene *Canobus*, is not much higher then the other buildings. But *Cnidus* is in the same Climate with *Rhodes*, as is also the *Gades*, with the Sea coasts adjoyning. Thus *Strabo*. But what doth he conclude hence against *Ptolomy* ? That *Canobus* may be seene in *Cnidus* ? Wee deny it not. Or that *Cnidus* is in the *Rhodian* Climate ? *Ptolomy* acknowledgeth as much : for hee makes it to have not above 36. gr. 15. m. of latitude, in the fifth booke of his *Geography*. But is not *Ptolomy* out also in assigning the latitude of *Cnidus* ? That the latitude of *Rhodes* is no greater then *Ptolomy* hath set it, may be proved even out of *Proclus* himselfe : for he makes the longest day at *Rhodes* to be 14. houres and an halfe. And *Ptolomy* will have the same to bee equall both at *Rhodes*, and *Cnidus*. And to this assenteth *Strabo* likewise, save onely that in one place he sets it downe to be but 14. houres bare : so that by this reckoning it should have lesse latitude. Now *Proclus* his words are these. In the Horizon of *Rhodes* (saith hee) the Summer Tropique is divided by the Horizon in such sort, as that if the whole circle bee divided into forty eight parts, twenty nine of the
same

same doe appeare above the Horizon, and 19. lye hid under the Earth. Out of which division it followes, that the longest day at *Rhodes* must be 14. Equinoctiall houres and an halfe, and the shortest night, 9. and an halfe, Thus he; I doe not deny, but that *Posidonius* his setting downe of the quantity of the portion of the Meridian intercepted betwixt the verticall point of *Rhodes* and *Alexandria*, might deceive *Pliny*, *Proclus*, and others. Yet *Alfraganus* draweth his second Climate through *Cyprus* and *Rhodes*, and maketh it to have the longest day of 14. houres and an halfe, and in latitude 36. gr. two thirds. So that here is but very small difference betwixt him and *Ptolomy*. And even *Maurolycus* himselfe, when in his Cosmographical Dialogues he numbrell up the Parallels, hee maketh that which passeth through *Rhodes* to have 36. gr. and a twelfth of latitude : herein differing something with the most from *Posidonius*. *Eratosthenes* his observations also doe very much contradict *Posidonius*. For *Eratosthenes* saith, that hee found by Sciotericall Gnomons, that the distance betwixt *Rhodes* and *Alexandria* was 3750. furlongs. But let us examine this a little better. The difference of latitude betwixt these two places he found Scioterically, after his manner, to be something more than 5. degrees. And to this difference, (according to his assumed measure of the compasse of the Earth, wherein he allowes 700. furlongs to a degree) hee attributes 3650. furlongs. Neither is there any

other way of working by Scioterickall instruments (that I know) in finding out the distance of furlongs betwixt two places ; unless we first know the number of furlongs agreeing either to the whole circumference of the Earth, or else to the part of it assigned. Let us now see if we can prove out of the observations of *Eratosthenes* himselfe, that neither *Possidonius* his opinion concerning the measure of the Earths circumference, much lesse *Eratosthenes* his owne can be defended. And here we shall not examine his observation of the difference of latitude betwixt *Alexandria* and *Syene*, that so we might prove out of his own assumptions, that the whole compasse of the Earth cannot be above 241610. furlongs : as it is demonstrated by *Petrus Nonius*, in his lib. 2. cap. 18. *De Navigatione*. Neither doe we enquire, how truely hee hath set downe the distance of these two places to bee 5000. furlongs : whereas *Solinus* reckoneth not from the very Ocean to *Meroë* above 620. miles, which are but 4960. furlongs. Now *Meroë* is a great deale farther than *Syene*. Neither will we question him at all, concerning the small difference that is betwixt him and *Pliny*, who reckons from the Island *Elephantina* (which is 3. miles below the last Cataract, and 16. miles above *Syene*) to *Alexandria* but 486. miles : so that by this reckoning, betwixt *Syene* and *Alexandria*, there will not be above 4560. furlongs. But we will proceed a contrary way to prove our assertion. This one thing therefore we

we require to be granted us ; Which is : that looke how great a space the Sunnes Diameter taketh up in his Orbe ; for the like space on the *Terrestriall Globe* shall the *Gnomons* be without any shadow at all, while the Sunne is in their Zenith. Which if it be granted, (as it is freely confessed by *Posidonius* in *Cleomedes*.) we have then gotten the victory.

Now it is affirmed by *Eratosthenes*, that the Sunne being in the beginning of Cançer, and so directly in their verticall point at *Syene* ; both there, and for 3000. furlongs round about, the *Gnomons* cast no shadow at all. Let us now therefore see, how great a part of his Orbe the Sunnes Diameter doth subtend. For by this meanes, if this position of *Eratosthenes*, which wee have now set downe, bee true ; we may easily finde out by it the whole circuit of the Earth. *Firmicus Maternus* makes the Diameter both of the Sun and Moone to be, no lesse then a whole degree. But he is too farre from the truth : and assigneth a greater quantity, either then he ought, or wee desire. The *Egyptians* found by Hydroscopicall instruments, that the Diameter of the Sunne takes up the Seven hundred and fiftieth part of his Orbe. So that if 300. furlongs on Earth answer to the seven hundred and fiftieth part of the whole circumference of the same : the whole circuit of it then will bee but 225000. furlongs. The fabricke and use of this instrument is set downe by *Proclus* in his *cap. 3. Designation. Astronomi.* And *Theon* also speaks much

much of it in his Commentaries upon the 5. lib. *Almagest*. *Ptolom*, as also doth *Maurolycus* in his third *Dialog. Cosmograph*. But these kindes of observations are not approved of by *Ptolomy*. And *Theon* also, and *Proclus* demonstrate them to bee obnoxious to much error. And therefore we examine the matter yet a little further.

Aristarchus Samius, (as he is cited by *Archimedes*) affirmed, that the Suns apparent Diameter taketh up the seven hundred and fiftieth part of the Zodiaque, that is to say, 30. minutes; and is equall to the apparent Diameter of the Moon: as he hath it (as I remember) in the 7. and 8. Propositions of his booke *De magnitud. & distant. Solis & Luna*. The same was the opinion also of *Archimedes* himselfe. But in the meane time I cannot free my selfe of a certaine scruple cast in my way, by another supposition of the same *Aristarchus*, in the very same booke, where he would have the Diameter of the Moone to bee 2. degrees. *Archimedes* also out of his owne observations by Dioptrickall instruments, hath defined the Suns Diameter to bee greater then the 200th part of a right angle, that is to say, 27. minutes: yet lesse then the 164th part of a right angle, which is 33. minutes. But he himselfe confesseth, that there is no so great credit to be given to such like observations, as are made by these Dioptrickall instruments, as by them to bee able exactly to find out the Diameter of the Sunne or Moone: seeing that neither the sight, nor the hand, nor yet

yet the instruments themſelves, by which the obſervations are to be made, can be every way ſo exact and ſure, as not to faile. *Ptolomy* by the ſame Dioptricall inſtrumemts, as alſo by the manner of Eclipſes; found the Diameter of the Sun to containe 30. m. 20. ſec. and to be equall to the apparent Diameter of the Moone, when ſhe is at the greateſt diſtance from the earth, which is, at the full Moone, and in Conjunction with the Sunne. Now whether he would have this magnitude to bee conſtantly the ſame, and invariably: *Proclus* approves not of him herein, as appears in his 3. cap. *Deſignation. Aſtronom.* being hereto induced by the authority of *Sofiſgenes* a Peripateticke: who in thoſe bookes of his, which he intituleth, *De revolutionibus*, hath obſerved, that in the Eclipſes of the Sun, there is ſometimes a certaine little ring or circle of the Sun to be perceived enlightned, and appearing plainely on all ſides round about the body of the Moone. Which if it be true, it is impoſſible then, that the apparent magnitude of the Sunne ſhould bee at all times equall to that of the Moone in their Conjunctions and oppoſitions. And this is the cauſe perhaps, that thoſe that have come after *Ptolomy*, have endeavour'd to examine theſe things more accurately. And firſt of all *Albatemi* found the Diameter of the Sunne, when he was in the *Apogaeum* of his Eccentricke, to be 31. m. 20. ſec. which is the ſame with *Ptolomies* obſervation: but in the *Perigaeum*, to be 33. m. 40. ſec. But *Copernicus*

pernicus went yet further, and found the Diameter of the Sunne, when he was in his greatest distance from the Earth, to be 31. m. 48. sec. and when he is nearest of all, to be 33. m. 54. sec. Now therefore if we worke upon this ground here laid before us, and take the Diameter to be 32. m. it will then follow, that if 300. furlongs answer to 32. minutes, the whole circuite of the Earth will bee but 202500. furlongs : which falls short of that measure which *Posidonius* hath set downe, but much more of that which *Erastosthenes* hath delivered. And thus much have we thought good to say (with all due reverence to the judgements of learned Authors) in examination of those things, which have been delivered by the Greekes, concerning the measure of the Earths circumference.

The way of measuring used here with us, is by Miles, and Leagues : of the former whereof 60. and of the later 20. answering to a degree. So that the circumference of the Earth, containeth 21600. English Miles : which also agrees exactly with that of *Ptolomy*. For we find our English foot to be just equall with the *Grecian*, by comparing it with the *Grecian* foot, which *Agricola*, and others have delivered unto us, out of their monuments of antiquity. Now one of our Miles containeth 5000. feet of our English measure : and a furlong 600. *Grecian* feet. Now if you multiply the measure of a furlong by 500. (for so many furlongs doth *Ptolomy* allot to a degree) and
fo

so likewise the measure of a Mile, which is 5000. feet, by 60. (which is also the number of miles that we reckon for a degree,) they will both produce the same number of feet, viz. 300000. So that from these grounds we may certainly conclude, that the common computation received among our Mariners, doth agree most exactly with that of *Ptolomy*.

The *Italians* also make 60. miles to be the measure of a degree: but their measure is something lesse then *Ptolomies*. The *Germans* reckon 15. miles to a degree: one of their miles containing 4. *Italian*: so that this reckoning of theirs falls just as much short of *Ptolomyes*, as the *Italian* doth. For according to their computation, a degree containeth not above 480. furlongs, every *Italian* Mile consisting but of 8. furlongs: (unlesse perhaps you rather approve of *Polybius* his opinion, who, (as he is cited by *Strabo*,) over and above 8. furlongs, will have 2. *Plethra*, which is the third part of a furlong, to be added to every mile: which is the just measure of our English mile.) Yet *Appian* saith that 15. *Germane* miles, are as much, as 60. *Italian*: and 60. *Italian* miles containe 480. furlongs: which is lesse then *Ptolomies* measure by 20. furlongs, which make up two *Italian* miles, and an halfe.

The *Spaniards* reckon to a degree, some of them 16. leagues and two third parts: and some seventene and an halfe. But how their measure stands, compared with the Grecian furlongs, or with the English, Italian, or Ger-

mane miles, I have not yet certainly learned. Yet *Nomius* seemeth to equall the Spanish league with the *Schœnius*, or *Parasanga*: which if it be so, then those that allow 16. leagues and 2. thirds to a degree, have the same measure that *Ptolomy* hath delivered: but those that allow 17. and an halfe, make it somewhat too large.

It only now remaineth to see, what is the doctrine of the *Arabians* concerning this matter. Of which the most ancient have assigned to the whole circumference of the Earth, 24000. Miles, or 8000. *Parasanga*: so that after this computation, a Degree must containe 66. Miles, with two third parts. And this measure is used by *Alhazenus*, in the end of his booke, *De Crepusculis*. *Alfraganus*; and some of the later Arabicke writers, since *Almamons* time, do generally account 20400. Miles to be the just measure of the *Terrestriall Globe*: So that one degree containeth, by this reckoning, 56. Miles and a third part. And it is reported by *Abulfedea*, in the beginning of his Geography, how that by the command of *Almanon*, King of the *Arabians*, or Caliph of *Babylon* there were certaine men employed, who should observe in the plaine field of *Singar* and the adjoyning Sea coasts, (meaning the places in a direct line toward the Pole,) how many miles answered to a degree: and that they found, by just computation, that in going the space of one degree, there were spent full 56. miles without any fractions, and sometime 56. miles, and a third part which make up

1333. cubits, with two Thirds. But now what proportion the *Arabian* Mile beareth to ours, or the *Italian*, or *Germane* Mile, is not so easie to determine. Yet I conjecture it cannot be lesse than tenne furlongs. The *Parasanga* (as *Iacobus Christmannus* tells us, out of *Abulfeda*, that great *Arabian* Geographer) containeth three *Arabian* Miles, according to the doctrine both of the Ancient, and Moderne Writers among them. Now a *Parasanga* (as it appeares plainely out of *Herodotus*, *Xenophon*, and others) containeth thirtie furlongs: so that by this account every mile must comprehend tenne furlongs. And for confirmation of this we may observe, that among the Greekes there were two kinds of Cubits in use; the one, the common or ordinary Cubit, which contained two foot and an halfe of *Grecian* measure, or twenty foure digits, of which sixteene went to a foot. The other was the Kings Cubit, in use among the *Persians*: which was greater than the common Cubit by three fingers breadth. Now *Alfraganus* affirmeth, that the *Arabian* mile contained 4000. Cubits, according to the ordinary measure. So that if this Cubit be equall to the *Grecian* Cubit, one of their miles will then containe 6000. *Grecian* feet, which make up tenne furlongs. Now whereas the *Parasanga* is reckoned by some to containe 40. furlongs, and by others 60. yet no body allotteth to it lesse then 30. with which later account if we should, with *Herodotus*, *Xenophon*, and others, rest our selves contented

tented (neither indeed is it our intention to stand long in disputing, whether or no in diverse places, the measure of the *Parasanga* were also different, as *Strabo* seemes to thinke, who observed the very same difference in the Egyptians *Schaenus*, when as being conveighed on the River *Nilus* from one City to another, he observed that the Egyptians in diverse places, used diverse measures of their *Schaenus* :) I say, if we should rest upon their determination, who assigne but 30. furlongs to a *Parasanga*; then one of the *Arabian* miles will containe tenne furlongs at the least. Which conjectures if they be true; we cannot then assent to those learned men, *P. Nonius*; and *Jacobus Christmannus*, who will have the *Arabian* Mile to be all one with the *Italian*.

In this so great diversity of opinions, concerning the true measure of the Earths circumference, let it be free for every man to follow whom soever he please. Yet were it not that the later *Arabians* doe countermand us, by proposing to us their Positions, which they averre to have beene grounded upon most certaine and exact mensurations of the distances of places: we should not doubt to preferre *Ptolomies* opinion before the rest. And for your better satisfaction, I will here propose unto your view a list of all those opinions, which carry in them any shew of probability.

{AUTHORS} {FURLONGS.}

The circuit of
the whole earth
containeth ac-
cording to

{*Strabo*, and {252000.
Hipparchus, {
Eratosthenes {250000.
Posidonius and {
the Ancient {240000.
Arabians, {
Ptolomy and {
our English- {180000.
men {
The moderne {
Arabians, {204000.
The Ita- {
lians and {172800.
Germans, {

{AUTHORS.} {FURLONGS.}

The measure of
a Degree ac-
cording to

{*Strabo*, and {700.
Hipparchus {
Eratosthenes {694.
Posidonius and {
the Ancient {666.
Arabians, {
Ptolomy and {
our English- {500.
men {
The later {
Arabians, {566.
Italians and {
Germans {480.

N

Miles.

{ MILES. } { FURLONGS. }

The { Italian } { 8. }
 { English } { 8 $\frac{1}{2}$. }
 { Arabian } { 10. }
 { Germane } { 32. }

PONT. For the finding out of the circumference or circuit of the Terrestriall Globe, these Hypotheses are first to bee laid downe for a ground. 1. That the greatest circle in the Earth, as well as in the Heavens, is to bee divided into 360. parts, or degrees. 2. That one of these degrees doth containe 500. furlongs, or 62500. Romaine pases, and 60. English miles, 3. The 8. furlongs, and a third part make an English Mile.

These things being presupposed, we must multiply 360. degrees by 60. miles, which done, the product will be 21600. English miles. Or if you multiply 360. degrees, by 500. furlongs; the whole will be 180000. furlongs, which is the measure of the circumference of the Earth.

So likewise if 360. be multiplied by 15. the whole will be 5400. Germane miles: and if the number of the degrees be multiplied by 25. there will arise 9000. French miles. All which may be thus expressed in a Table.

A degree containeth	{	15. Germane	{	Miles, each	{	4000.
		60. Italian		of w ^{ch} containe		1000.
		60. English		leve-		1000.
		25. French		rally		
		17 $\frac{1}{2}$. Spanish				2400.

In like manner the Circumference of the Earth may as easily bee found out by any of the five

Starts

Starrs, as the Virgins Spike, or the like. For if
We take any two places which are situate under
the same Meridian, and the distances in a right
line exactly knowne, so that in both places the
Meridian Altitude of the same Star be certain-
ly knowne also: the difference of its Altitude will
be the number of degrees of distance betwixt the
same places. Wherefore seeing it is certainly
knowne, as we have already said, how many miles
answer to a degree, it is very easie then to gather;
how many miles the circumference of the whole
Earth is also. As for example: suppose London
and Edenburgh in Scotland to be under the same
Meridian, and the Elevation of the Pole at Lon-
don to be 52. degrees, and at Edenburgh 56.
gr. 20. m. Now if you substract the lesser num-
ber, which is 52. from the greater, 56. gr. 20.
m. the difference will bee 4. gr. 20. m. which be-
ing resolved into minutes, it will be found to bee
260. the distance of miles betwixt London and
Edenburgh. Therefore wee must now say, that
as 4. gr. 20. m. is to 260. miles: so is 360. de-
grees to 21600. English miles.

N 2

The



The fourth Part,

Of the Vse of Globes.



Itherto wee have spoken of the *Globe* it selfe, together with its dimensions, circles, and other instruments necessarily belonging thereto. It remaineth now that we come to the practise of it, and declare its severall uses. And first of all it is very necessary for the practise both of Astronomy, Geography, and also the Art of Navigation. For by it there is an easie and ready way laid downe, for the finding out both of the place of the Sun, the Longitudes, Latitudes, and Positions of places, the length of dayes and houres; as also for the finding of the Longitude, Latitude, Declination, Ascension both Right and Oblique, the Amplitude of the rising and setting of the Sunne and Starres, together with almost an infinite number of other like things. Of the chiefe of all which wee intend here briefly to discourse, omitting the enumeration of them all, as being tedious and not futable to the brevity we intend. Now that all these things may be performed farre more accurately, by the helpe of numbers,

numbers, and the doctrine of Triangles, Plaines, and Sphæricall bodies, is a thing very well knowne to those that are acquainted with the Mathematickes. But this way of proceeding, besides that it is very tedious and prolix, so likewise doth it require great practise in the Mathematickes. But the same things may be found out readily and easily by the helpe of the *Globe*, with little or no knowledge of the Mathematickes at all.

PONT. For the better understanding of those things which shall be spoken hereafter, there are two things especially to be premised: the first whereof is, concerning the position of the *Globe*, and the other *Climates*. Now touching the position of the *Globe*, you are first of all to take care that it be placed perpendicularly to the true *Horizon*. 2. That the distinction of the windes answer directly to the windes of the reall *Horizon*, that so the *East* on your materiall *Globe*, may looke directly toward the true *East* of the *World*. For which purpose especially there is usually placed a *Nauticall Compass* in the bottome of the frame. When you have thus placed your *Globe*, so that it may be turned about any way at pleasure, yet so that the base or foot be not moved out of its place, the next thing that is to be enquired after, is the latitude of the place wherein you live: which according as it is greater, or lesse, you must elevate the *Pole* of your *Globe* above the *Horizon* proportionably. As for example, if the latitude be 50. 51. or 52. grad. or more, or lesse Northward, then must you elevate the *Arcticke Pole* just so many

N 3 degrees

degrees above the Horizon. And so likewise if the latitude be Southerne, you must doe the like by the Antarticke or South Pole. But under the Equator, where there is no latitude at all, both the Poles must be placed in the very Horizon, at opposite points.

2. A Climate is a space of the habitable parts of the Earth, comprehended betwixt two circles parallel to the Equator, in which space there is halfe an houres difference in the longest day. Now those that inhabite under the Equator have a perpetuall Equinoxe, for the day with them is alwayes twelve houres long, and the night as much. But as their situation is removed from the Equinoctiall nearer to either Pole, the farther they are from the Equinoctiall, the greater is the inequality of the Artificiall day and night: out of which variation of Artificiall daies, the diversity of Climates also is taken and distinguished. For wheresoever this difference amounteth to halfe an houre, there presently begins another Climate. Now the ancient Geographers constituted in every Clime three Parallels, of which the two outwardmost, namely the first and the third, do comprehend and terminate every Climate: and the second divideth it in the midst. So that the proportion betwixt the Clime and the Parallels was Triple; for the Climes, as we have said, were distant from each other halfe an houres space in the length of the day, but the Parallels were distinguished by quarters of an houre.

Now as concerning the number of Climates,
The

The Ancients at first reckoned but seven, but Ptolomy in his Tables of Ascensions, in the 2. lib. May. Construction. acknowledgeth nine: all of which deriv'd their names from some eminent place, either hill or river, situate in the midst of the said Climate. The first Clime toward the Arcticke Pole, beginning from the Equator, they called Diameroës, because the midst of this Climat runneth through Meroë, which is an Island in Africke encompassed about with the river Nilus, where the longest day is thirtene houres: in the beginning therefore of this Clime it must bee 12¹/₂ houres long. On the opposite part of the Equator, the first Southerne Climate may in like manner bee called, Antidiameroës. But these other Climes were not constituted neither by Ptolomy, nor any of the ancient Geographers. Yet by the like reason that part of the world also may as well be distributed into Climats, reserving the same names that the Northerne Climes are known by, and onely adding to them the preposition αντι, which signifies as much as, Opposite, or over against. And then the Scheme of them all will be thus.

Northerne Climates. Southerne Climates.

- | | |
|--------------------|------------------------|
| 1. Diameroës. | 1. Antidiameroës. |
| 2. Diasyenes. | 2. Antidiasyenes. |
| 3. Dialexandrias. | 3. Antidialexandrias. |
| 4. Diarhodū. | 4. Antidiarhodū. |
| 5. Diarhōmes. | 5. Antidiarhōmes. |
| 6. Diapontū. | 6. Antidiapontū. |
| 7. Diaboristhenes. | 7. Antidiaboristhenes. |
| 8. Diabritanias. | 8. Antidiabritanias. |
| 9. Diatanaidos. | 9. Antidiatanaidos. |

Yet some there are, that doe not approve of this distinction of *Climates*, among whom is Ioh. Gigas, in his lib. 2. *System. Geograph.* cap. 3. probl. 12. and the reasons they alleadge are these.

1. Because of their great inequality; in so much that the latitude of the first is above 470. English miles, whereas the last of all is scarce a mile.
2. Because that the encrease of houres is but a weake ground to build upon, and of no great use: seeing it is as easie to enquire out the length of the day, as the number of the *Climate*. And therefore he thinkes, it were farre better, that every Hemisphere were equally distinguished by tenne degrees into nine *Climates*. So that the first *Climate* should begin at the *Aequinoctiall*, and end where the Elevation of the Pole is tenne gr. which might bee called, the *Aethiopian Climate*. The second should reach to the 20. gr. and should be named the *Arabian Climate*: because that part of Arabia Felix is situate therein, The third should reach to the 30. gr. and be called the *Aegyptian*. The fourth the *Syrian*, ending at the 40. gr. The fifth the *Italian*, to the 50. gr. The 6. the *English*, or *Germane*, extending to the 60. gr. The seventh the *Succian*, or *Lapland Climate*, reaching to the 70. gr. The eighth, the *Frozen Climate*, ending at the 80. gr. and the ninth and last the *Polar Climate*, reaching to the Pole itselfe.

So likewise the same Method might be observed on the other side of the *Aequinoctiall*: and then by this meanes each Hemisphere should have nine *Climates*: whereof seven would be conveni-

ent for habitation, and the Parallels might passe through every fifth degree. And the situation of any place might bee knowne by the number of degrees of the Poles elevation. So Rome, because it hath above 40. gr. of latitude is in the fourth; Westphalia in the fifth; Sicily in the third; Calcut, the chiefe City in India, in the second; Zeilan in the first; and so of the rest.

CHAP. I.

How to finde the Longitude, Latitude, Distance, and Angle of Position, or situation of any place expressed in the Terrestriall Globe.

THe Ancient Geographers from Ptolemies time downeward, reckon the longitude of places from the Meridian which passeth through the *Fortunate Islands*: which are the same that are now called the *Canary Islands*, as the most men doe generally beleevē; but how rightly, I will not here stand to examine. I shall only here advertise the reader by the way, that the latitude assigned by Ptolemy to the *Fortunate Islands*, falleth something of the widest of the *Canary Islands*, and agreeth a great deale nearer with the latitude of those Islands which are knowne by the name of *Cabo Verde*. For Ptolemy placed all the *Fortunate Islands* within the 10. gr. 30. m. and the 16. gr. of Northern latitude. But the *Canary Islands* are found

found to be distant from the *Equator* at the least 27. degrees. The *Arabians* began to reckon their longitude, at that place where the *Atlanticke* Ocean driveth farthest into the maine land : which place is tenne degrees distant Eastward from the Fortunate Islands : as *Jacobus Christmannus* hath observed out of *Abulfeda*. Our Moderne Geographers for the most part beginne to reckon the longitude of places from these *Canary* Islands : yet some beginne at those Islands which they call *Azores* : and from these bounds are the longitudes of places to be reckoned in these *Globes* whereof we speake.

Now the longitude of any place, is defined to be, an Arch, or portion of the *Equator* intercepted betwixt the Meridian of any place assigned, and the Meridian that passeth through *Saint Michaels* Island (which is one of the *Azores*) or of any other place, from whence the longitude of places is wont to be determined.

Now if you desire to know the longitude of any place expressed in the *Globe* : you must apply the same place to the Meridian, and observing at what place the Meridian cutteth the *Equator*, reckon the degree of the *Equator* from the Meridian of *Saint Michaels* Island to that place : for so many are the degrees of longitude of the place you looke for.

In the same manner may you measure the difference of longitude betwixt any other two places that are described in the *Globe*. For the difference

difference of longitude is nothing else, but an Arch of the *Æquator* intercepted betwixt the Meridians of the same places. Which difference of longitude, many have endeavoured to set downe diverse wayes how to find by observation. But the most certaine way of all for this purpose, is confessed by all learned Writers to be, by the Eclipses of the Moone. But now these Eclipses happen but seldome, but are more seldome seene, yet most seldome and in very few places observed by the skilfull Artists in this Science, So that there are but few longitudes of places designed out by this meanes. *Oronius Finam*, and *Iohannes Wernerus* before him, conceived that the difference of longitude might be assigned, by the known (as they presuppose it) motion of the Moone, and the passing of the same through the Meridian of any place. But this is an uncertaine and ticklish way, and subject to many difficulties. Others have gone other wayes to work: as namely, by observing the space of the *Æquinoctiall* houres betwixt the Meridians of two places: which they conceive may be taken by the helpe of Sunne Dials, or Clocks, or Houglasses either with water or sand, or the like. But all these conceits long since devised, having beene more strictly and accurately examined, have beene disallowed and rejected by all learned men, (at least those of ripper judgements) as being altogether unable to performe that which is required of them. But yet for all this, there are a kind of trifling Impostors

postors, that make publike sale of these toys or worke, and that with great ostentation and boasting; to the great abuse and expence of some men of good note and quality, who are perhaps better stored with money, then either learning or judgement. But I shall not stand here to discover the errours and uncertainties of these instruments. Only I admonish these men by the way, that they beware of these fellows; least when their noses are wiped (as we say) of their mony, they too late repent them of their ill-bought bargaines. Away with all such trifling cheating rascals.

PONT. If you would know how to find out the longitude of any place by the Eclipse of the Moone, you must first goe to some Ephemerides, as the Prutenicke Tables, or of any other learned Mathematicians calculation; and see, what houre such an Eclipse of the Moone shall happen at that place, for which the said Tables or Ephemerides were made. Then afterward you must observe the same Eclipse in that place, whose longitude you desire to know. Now if the time of the Eclipse agree with that other, for which the Tables were made, then you may conclude that both places have the same latitude, and are situate under the same Meridian. But if the number of the houres be more, then the place you are in is situate more Eastward, you must therefore subtract the lesse number out of the greater, and the remainder must be converted into degrees and minutes, multiplying the houres by fiftene and dividing the minutes of houres (if there be any) by

four;

four; for so will the number of degrees arise: and if there remaine any minutes after the division, they must be multiplied againe by fiftene, and so will the number of the minutes of degrees arise, by which these places are distant from each other: which distance is called the difference of longitude. This difference must bee added to the longitude of that place for which the Tables were calculated, if the other place be more Eastward: otherwise if it be more Westward, it is to be subtracted from the longitude of the other. An example hereof is thus proposed by Adrianus Metius in his *Doctrina Sphaerica*. I find (saith he) out of the Prutenicke Tables by exact calculation, that there will be an Eclipse of the Moone in the yeare 1598. upon the eleventh day of February, at foure of the Clocke and sixteene minutes, in the morning, and that at Regiomont, a City in Borussia, whose longitude, or distance from the Canary Islands, is 41. gr. 16. m. For this longitude were these Tables calculated. Now I set my selfe to observe this same Eclipse at Marburg, and find it to happen at three of the clocke and twelve minutes, on the same day of February. Now because the number of houres here is lesse, it appeares that Marburg is more Westward then Regiomont. Therefore I take away the lesse number from the greater, that is, 3. h. 12. m. from 4. h. 16. m. and the remainder is 1. h. 4. minutes: which sheweth the difference of longitude in houres, which make up sixteene degrees. Therefore I againe subtract these degrees of difference from the longitude of Regiomont, as being more Eastward
then

then Marpurg; and so I find the longitude of Marpurg from the Canary Islands, 30 to 25. gr. 16. minutes.

CHAP. II.

How to finde the Latitude of any place.

THe latitude of a place, is the distance of the Zenith, or the verticall point thereof from the Equator. Now if you desire to find out the latitude of any place expressed in the *Globe*, you must apply the same to the Meridian, and reckon the number of the degrees that it is distant from the Equator: for so much is the latitude of that place. And this also you may observe, that the latitude of every place is alwayes equal to the elevation of the same place. For look how many degrees the verticall point of any place is distant from the Equator, just so many is the Pole elevated above the Horizon: as you may prove by the *Globe*, if you so order it, as that the Zenith of the place be 90. degrees distant every way from the Horizon.

PONT. Seeing that the latitude of every place is alwayes equal to the elevation of the Pole: It will not be amisse to shew, how the elevation of the Pole, or the latitude of any region may be found out, by the observing of some fixed Starre in the heavens, which is so neare the Pole, as that it never sets in that region: which to do you must worke thus. You must observe both the least and also the greatest altitude of the said Starre;

Starre; both which must necessarily happen in the Meridian: the least whereof will be beneath the Pole, and the greatest above it. Which done, you must adde the least altitude of it to the greatest; and so the halfe of the degrees thus numbered together, will be the altitude of the Pole, and latitude of that place. An example whereof may be this. The first Starre of the three in the taile of the great Beare is in his least altitude observed at London to be about 11. gr. and the greatest altitude of the same, when it is above the Pole, is found to be neare upon 92. degrees. Both which numbers being added together, doe make up 103. halfe of which summe, namely 51½. is the true elevation and latitude of London.

CHAP. III.

How to find the distance of two places, and angle of position, or situation.

IF you set your Globe in such sort, as that the Zenith of one of the places be 90. gr. distant every way from the Horizon, and then fasten the Quadrant of Altitude to the Verticall point, and so move it up and downe, untill it passe through the Vertex of the other place: the number of degrees intercepted in the Quadrant betwixt the two places, being resolved into furlongs, miles, or leagues, (as you please) wil shew the true distance of the places assigned. And the other end of the Quadrant, that toucheth

toucheth upon the Horizon, will shew on what wind or quarter of the world the one place is in respect of the other, or what Angle of Position (as they call it) it hath. For the Angle of Position is that, which is comprehended betwixt the Meridian of any place, and a greater circle passing through the Zeniths of any two places assigned: and the quantity of it, is to bee numbred in the Horizon.

As for Example. The longitude of *London* is twentie sixe degrees, and it hath in Northerne latitude 51. degrees, and an halfe. Now if it be demanded, what distance and angle of position it beareth to Saint *Michaels* Island, which is one of the *Azores*: we must proceed thus to find it. First, let the North Pole be elevated 51 $\frac{1}{2}$. degrees: which is the latitude of *London*. Then fastning the Quadrant of Altitude to the Zenith of it, that is to say, fiftie one degrees and an halfe Northward from the *Aequator*, we must turne it about, till it pass through Saint *Michaels* Island: and we shall finde the distance intercepted betwixt these two places to be 11. gr. 40. m. or thereabout: which is 280. of our leagues. And if we observe, in what part of the Horizon the end of the Quadrant resteth, we shall find the Angle of Position to fall neare upon 50. gr. betwixt Southwest and by-west. And this is the situation of this Island in respect of *London*.

P O N T. The distance of places differing only in latitude may bee found after this manner.

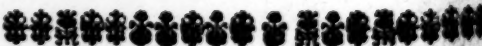
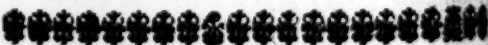
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First you must substract the lesser latitude from the greater, resolving a degree into minutes, if the subtraction cannot be done otherwise conveniently. Then multiply the degrees by 15. and divide the minutes by 4. and the summe produced will be the distance of those two places in common Germane miles, one whereof containeth foure of our English miles. As for example: Basile in Germany, and Geneva have both the same longitude; but differ in latitude, which at Basill is 47. gr. 30. m. and at Geneva 45. gr. 45. m. Therefore subtracting the lesser from the greater, the remainder will be 1. gr. 45. m. which being reduced into Germane miles, will amount to 26. and a quarter of a mile: which is the distance of these two places assigned.

Now if the places proposed be in diverse Hemispheres, then the degrees and minutes of latitude must first be added together, and so the whole resolved into miles, as formerly hath beene said. As for example: The Cape of good hope in Africa, and Constantinople are almost situate under the same Meridian, but in diverse Hemispheres: Now the elevation of the Pole Articke at Constantinople is 43. gr. or thereabout: and at the Cape of good hope the Antarti:ke Pole is elevated about 35. gr. the whole summe therefore is 78. degrees, that is to say, 1170. Germane miles.

The distance of places differing only in longitude, is found thus. First substract the lesse number from the greater: then looke in the Table hereunder written, how many miles answer to a degree in every Parallel, seeking for the degree of latitude

tude in the first columnne descending, and the number of miles over against it. Then lastly let the difference of longitude be multiplied into miles and minutes: and you have your desire. As for example: Naples and Ilium, or Troy, are in the same latitude of fortie one gr. where eleven Germane miles, and nineteene minutes answer to a degree of that Parallel: but these places differ in longitude, which at Naples is 39. gr. 30. m. but at Troy 55. gr. 50. m. Now the difference betwixt them, is 16. gr. 20. m. which is as much as 184 Germane miles, and fiftie scruples: the just distance betwixt these two places.



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A Table of Miles answering to a Degree in each several Latitude.

Miles.			
Scrup.	Englsh.	Scrup.	Englsh.
1	59	1	59
2	58	2	58
3	53	3	53
4	51	4	51
5	46	5	46
6	40	6	40
7	33	7	33
8	25	8	25
9	16	9	16
10	5	10	5
11	54	11	54
12	41	12	41
13	28	13	28
14	13	14	13
15	57	15	57
16	41	16	41
17	23	17	23
18	4	18	4
19	44	19	44
20	23	20	23
21	1	21	1
22	38	22	38
23	14	23	14
24	49	24	49
25	23	25	23
26	56	26	56
27	28	27	28
28	59	28	59
29	29	29	29
30	58	30	58
31	26	31	26
32	53	32	53
33	19	33	19
34	45	34	45
35	9	35	9
36	32	36	32
37	55	37	55
38	17	38	17
39	38	39	38
40	58	40	58
41	17	41	17

Miles.			
Scrup.	Englsh.	Scrup.	Englsh.
1	44	1	44
2	53	2	53
3	10	3	10
4	26	4	26
5	41	5	41
6	55	6	55
7	9	7	9
8	22	8	22
9	34	9	34
10	46	10	46
11	56	11	56
12	7	12	7
13	16	13	16
14	25	14	25
15	33	15	33
16	41	16	41
17	48	17	48
18	54	18	54
19	0	19	0
20	5	20	5
21	10	21	10
22	14	22	14
23	18	23	18
24	21	24	21
25	24	25	24
26	27	26	27
27	29	27	29
28	31	28	31
29	33	29	33
30	35	30	35
31	37	31	37
32	39	32	39
33	41	33	41
34	43	34	43
35	45	35	45
36	47	36	47
37	49	37	49
38	51	38	51
39	53	39	53
40	55	40	55
41	57	41	57

Miles.			
Scrup.	Englsh.	Scrup.	Englsh.
1	33	1	33
2	17	2	17
3	16	3	16
4	15	4	15
5	14	5	14
6	13	6	13
7	12	7	12
8	11	8	11
9	10	9	10
10	9	10	9
11	8	11	8
12	7	12	7
13	6	13	6
14	5	14	5
15	4	15	4
16	3	16	3
17	2	17	2
18	1	18	1
19	0	19	0
20	0	20	0
21	0	21	0
22	0	22	0
23	0	23	0
24	0	24	0
25	0	25	0
26	0	26	0
27	0	27	0
28	0	28	0
29	0	29	0
30	0	30	0
31	0	31	0
32	0	32	0
33	0	33	0
34	0	34	0
35	0	35	0
36	0	36	0
37	0	37	0
38	0	38	0
39	0	39	0
40	0	40	0
41	0	41	0

The Longitude or Latitude of any place or City being knowne, either by observation, as hath already beene shewed, or else out of some Geographical Table, the situation of the same in the Globe may also bee found out by this meanes. You must first reckon the Longitude of your place, among the circles of Longitude which are described upon the Globe, beginning at that which is drawne through the Fortunate Islands: and observe the circle where you end your reckoning. Then if the Latitude of your place bee Northerne: you must reckon that also among the Parallels toward the Arcticke Pole, beginning from the Equator: but if it have Southerne Latitude, you must then proceede in like manner, but reckon toward the Antarctique. And the Interseccion, or poynt where these two circles cut each other, sheweth the situation of your place. But if these circles of Longitude be not expressed in your Globe, then must you place that degree of the Equinoctiall, that answereth to the Longitude of your place, under the Meridian, and so reckon the Latitude of your place among the degrees of the Meridian, toward either Pole: and you have the situation of the place you looke after.



A Table of the Longitudes and Latitudes of some certaine Cities of note.

	Longit.	Latit.		Longit.	Latit.
Alexandria	60. 30	43. 42	Gant	19. 8	51. 24
Amsterdam	21. 43	52. 30	Graningen	22. 54	53. 16
Antwerp	20. 16	51. 28	Heidelberg	25. 38	49. 35
Athens	52. 45	37. 15	Jena	29. 2	51. 8
Bruxells	20. 42	51. 0	Lubeck	28. 30	54. 48
Bremen	35. 16	53. 40	Leiden	20. 47	52. 10
Bamberg	28. 10	49. 56	Regius Mos	46. 45	54. 21
Basell	24. 22	47. 41	Bornss.		
Bononia	32. 5	43. 54	London	25. 50	51. 32
Constantin.	56. 0	42. 5	Marpurg	25. 16	51. 0
Cassell	26. 36	51. 43	Millaine	38. 20	45. 6
Colem	33. 26	51. 0	Norimberg	28. 20	49. 24
Corinth	31. 15	36. 55	Naples	30. 10	41. 0
Dresden	38. 5	51. 6	Orleans	15. 36	47. 16
Dover	28. 10	51. 0	Oxford	24. 0	52. 0
Dantzick	39. 2	54. 54	Prage	32. 0	50. 6
Dublin	16. 40	53. 10	Paris	25. 25	48. 30
Erford	28. 40	51. 10	Ratisbane	29. 50	48. 56
Eltinga	36. 36	48. 39	Restock	30. 14	54. 36
Francford			Spier	35. 39	49. 20
ad Man.	25. 38	50. 12	Tubing	20. 23	48. 38
Ferraria	32. 15	44. 23	Vienna	34. 30	47. 44
Genna	28. 20	43. 50	Torke	23. 30	54. 30

CHAP. IV.

*To finde the Altitude of the Sunne, or other
Starres.*

THe Altitude of the Sunne, or other
Starre, is the distance of the same,
reckoned in a greater Circle, pas-
sing the Zenith of any place and
the body of the Sunne, or Starre. Now that
the manner of observing the same is to be per-
formed either by the Crosse Staffe, Quadrant,
or other like Instrument, is a thing so well
knowne, as that it were vaine to repeat it.
Gemma Frisius teacheth a way, how to ob-
serve the Altitude of the Sunne by a Sphari-
call Gnomon. But this way of proceeding
is not so well liked, as being subject to many
difficulties and errours: as, whosoever proves
it, shall easily find.

CHAP. V.

*To finde the place and Declination of the
Sunne, for any day given.*

HAving first learned the day of
the moneth, you must looke
for the same in the Calendar de-
scribed on the Horizon of your
Globe. Over against which, in the same Ho-
rizon, you shall find the Signe of the Zodi-
aque,

aque, and the degree of the same, that the Sunne is in at that time. But if it be Leape year, then for the next day after the 28th. of February you must take that degree of the Signe, which is ascribed to the day following it. As for example, if you desire to know, what degree of the Zodiaque the Sunne is in, the 29th. of February, you must take that degree which is assigned for the first of March, and for the first of March, take the degree of the second; and so forward. Yet I should rather counsell, if the place of the Sunne be accurately to be knowne, that you would have recourse to some Ephemerides, where you may have the place of the Sunne exactly calculated for every day of the year. Neither indeede can the practise by the Globe in this case be so accurate, as othen times it is required to bee.

Now when you have found the place of the Sunne, apply the same to the Meridian, and reckon thereon how many degrees the Sunne is distant from the Æquator, for so many will the degrees be of the Sunnes declination for the day assigned. For the Declination of the Sunne, or of any other Starre, is nothing else but the distance of the same from the Æquator, reckoned on the Meridian. But the Sunnes Declination may be much more exactly found, out of those Tables which Mariners use, in which the Meridian Altitude, or Declination of the Sunne for every day in the year, and the quantity of it is expressed. One thing I shall

give you notice of by the way; and that is, that you make use of those that are latest made, as neare as you can. For all of them, after some certaine space of time, will have their errors. And I give this advertisement the rather, for that I have seene some, that having some of these Tables, that were very ancient, and written out with great care and diligence, (which notwithstanding would differ from the later Tables, and indeed from the truth it selfe, often times at least 10. m. and sometimes more) yet would they alwayes use them very constantly and with a kinde of religion. But these men take a geat deale of paines and care to bring upon themselves no finall errors.

PONT. You also finde out the Sunnes greatest Declination, by his greatest and least Altitude both in Summer and Winter, by substracting the least out of the greatest. For then halfe that which remaineth, will be the declination you seeke for So Regiomontanus at Vienna found the Meridian Altitude of the Sunne, at the Summer Solstice, to be 65. gr. 30. m. and the least Altitude of it, on the Winter Solstice, to be 18. gr. 30. m. when therefore he had deducted the least number, 18. gr. 30. m. out of 65. gr. 30. m. he found the remainder to be 47. gr. 0. m. the halfe of which was the Sunnes greatest declination, namely 23. gr. 30. m. which is the number of degrees now commonly received: notwithstanding it hath been since observed by some in our time to be somewhat lesse.

Now to know the Longitude of the Sunne for
any

any time, that is to say, in what degree of the Zodiacke hee is, you must doe thus. Soeke in the limbe of the Horizon for the day of the Moneth, for which you would know the Longitude of the Sunne: which found, you shall see over against it, among the Signes of the Zodiacke described also upon the Horizon, the degree of the Signe that exactly answereth to it, and which is the place of the Sunne for that day and Moneth. But if it bee Leape yeare, you must remember after the 28th. of February, to adde one day more still as you go: as if you should looke for the place of the Sunne on the 13th. March, you must take that degree which is set for the 14th. of March; which is the 3. gr. of V.

CHAP. VI.

How to finde the Latitude of any place, by observing the Meridian Altitude of the Sunne, or other Starre.



Observe the Meridian Altitude of the Sunne with the Crosse Staffe, Quadrant, or other like instrument, and having also found the place of the Sunne in the Eclipticke, apply the same to the Meridian, and so move the Meridian up and downe through the notches it stands in, untill the place of the Sunne be elevated so many degrees above the Horizon, as the Sunnes Altitude is. And the Globe standing in this position,

position, the Elevation of either of the Poles will shew the Latitude of the place wherein you are. An example whereof may bee this.

On the 12th. of Iune, according to the old Iulian account, the Sunne is in the first degree of *Cancer*, and hath his greatest declination $23\frac{1}{2}$ degrees. And on the same day suppose the Meridian Altitude of the Sunne to be 50. degrees. We enquire therefore now, what is the Latitude of the place where this observation was made. And this we finde out after this manner. We apply the first degree of *Cancer* to the Meridian, which we move up and downe, till the same degree be elevated above the Horizon 50. degrees: which is the Meridian Altitude of the Sunne observed. Now in this position of the Globe, we find the North Pole to bee elevated 63. *gr.* and an halfe: So that we conclude this to be the Latitude of the place, where our observation was made.

The like way of proceeding doe Mariners also use, for the finding out of the Latitude of places by the Meridian Altitude of the Sunne, and their Tables of Declinations: But I shall not here speake any further of this, as well for that the explication hereof doth not so properly concerne our present intention: as also because it is so well knowne to every body, as that the handling of it in this place would be needlesse and superfluous.

The like effect may be wrought by observing the

the Meridian altitude of any other Starre expressed in the *Globe*. For if you set your *Globe* so, as that the Starre you meane to observe, be so much elevated above the Horizon, as the Meridian Altitude of it is observed to be: the elevation of the Pole above the Horizon will shew the latitude of the place. But here I should advise, that the latitude of places bee rather enquired after by the Meridian Altitude of the Sunne, then of the fixed Starres: because the declinations, as wee have already shewed, are very much changed, unlesse they be restored to their proper places by later observations.

Some there are that undertake to performe the same, not only by the Meridian Altitude of the Sunne or Starre, but also by observing it at two severall times, and knowing the space of time, or Horizontall distance betwixt the two observations. But the practise hereof is prolix and doubtfull: besides that by reason of the multitude of observations that must bee made, it is also subject to many errours and difficulties. Notwithstanding the easiest way of proceeding that I know in this kind, is this that followeth.

To

To find out the Latitude of any place, by knowing the place of the Sunne, or other Starre, and observing the Altitude of it two severall times, with the space of time betwixt the two Observations.

First having taken with your Compasses the complement of the Altitude of your first Observation, (now the complement of the Altitude is nothing else, but the difference of degrees by which the altitude is found to be lesse then 90. degrees,) you must set one of the feet of your Compasses in that degree of the Ecliptique that the Sunne is in at that time: and with the other describe a circle upon the superficies of the *Globe*, tending somewhat toward the West, if the observation be taken before noone, but toward the East, if it be made in the afternoone. Then having made your second observation, and observed the space of time betwixt it and the former, apply the place of the Sunne to the Meridian, turning the *Globe* toward the East, untill that so many degrees of the *Æquator* have passed by the Meridian, as answer to the space of time that passed betwixt your observations, allowing for every houre fifteene degrees in the *Æquator*, and marking the place in the Parallel of the Sunnes declination that the Meridian crosseth

seth after this turning about of the *Globe*. And then setting the foot of your *Compass* in the very *Interfection*, describe an *Arch* of a *Circle* with the other foot of the *Compass* extended to the complement of the second observation, which *Arch* must cut the former circle. And the common *Interfection* of these two circles, twi shew the verticall point of the place willerein you are : so that having reckoned the distance of it from the *Equator*, you shall presently have the latitude of the same.

The same may be effected, if you take any *Starre*, and work by it after the same manner : or if you describe two circles mutually crossing each other, to the complements of any two *Starres*.

PONT. *The Meridian altitude of the Sun being found by the helpe of the Meridian circle, it will be very easie to find out the latitude of the place, or elevation of the Pole, in any region whatsoever. For seeing the Zenith or Vertex of every place is distant a quarter of a circle that is 90. degrees from the Horizon : if then, the Sun being in either of the Equinoctiall points, the Meridian altitude be substracted from 90. degrees ; the remainder will be the distance betwixt the Zenith of the place and the Equinoctiall circle : which will be the latitude of the same place. And the reason also of this deduction is manifest, because that the Equinoctiall Altitude of the Sun, is nothing else, but the Elevation of the Equator, the complement whereof is alwayes equall to the elevation of the Pole. But this will appeare more plaine by an example,*

example, which shall be thus. The Equinoctial altitude of the Sunne at Rome is 40. degrees: which being subtracted from 90. gr. the remainder, which is 42. gr. is the elevation of the Pole, and the latitude of Rome. So likewise here at London the Meridian altitude of the Sunne, when he is in the Equinoctiall, is found to be 38. degrees and an halfe: which being deducted out of 90. gr. which is the Quadrant of a circle, there will remaine $15\frac{1}{2}$ gr. which is the latitude of London, and the elevation of the Pole.

51. $\frac{1}{2}$

The same also may be done, by observing any one of the fixed Starres, which is so neare the Pole, as that it never sets in that Countrey, whose latitude you seeke. For you must observe both the greatest and least altitude of the same Starre; both which will happen in the Meridian: the least of them beneath the Pole, and the greatest above it. Which done, you must adde the least altitude to the greatest, and so dividing the whole into two parts, the halfe will be the altitude of the Pole. As hath beene shewed before.

CHAP. VII.

How to find the Right and Oblique Ascension of the Sunne and Starres, for any Latitude of place, and time assigned.



He Ascension of the Sun or Stars, is the degree of the *Æquator* that riseth with the same above the *Horizon*. And the Descension of it, is the degree of the *Æquator*, that goes under the *Horizon* with the same. Both these is either Right, or Oblique. The Right Ascension or Descension is the degree of the *Æquator* that ascendeth or descendeth with the Sunne, or other Starre, in a Right Sphere: and the Oblique is the degree that ascendeth, or descendeth with the same in an Oblique. The formes of these is simple and of one kind only: because there can be but one position of a Right Sphere. But the later is various and manifold, according to the diverse Inclination of the same.

Now if you desire to know the Right Ascension or Descension of any Starre, for any time and place assigned: apply the same Star to the Meridian of your *Globe*: and that degree of the *Æquator* that the Meridian crosseth at that situation of the *Globe*, will shew the Right Ascension and Descension of the same, and also divideth each Hemisphere in the midst at the same time with it.

And

example, which shall be thus. The *Equinoctial* altitude of the Sunne at Rome is 40. degrees, which being substracted from 90. gr. the residue, which is 42. gr. is the elevation of the Pole, and the latitude of Rome. So likewise at London the Meridian altitude of the Sunne when he is in the *Equinoctiall*, is found to be 42. degrees and an halfe: which being deducted from 90. gr. which is the Quadrant of a circle, will remaine $15\frac{1}{2}$ gr. which is the latitude of London, and the elevation of the Pole.

51. 2

The same also may be done, by observing the altitude of the fixed Starres, which is so neare the Pole, that it never sets in that Countrey, whose latitude you seeke. For you must observe both the greatest and least altitude of the same Starre; which will happen in the Meridian: the least of them beneath the Pole, and the greatest above it. Which done, you must adde the least altitude to the greatest, and so dividing the whole into two parts, the halfe will be the altitude of the Pole. As hath beene shewed before.

IRREGULAR PAGINATION.

descendeth with the Sunne, or other Starre, in a Right Sphære : and the Oblique is the degree that ascendeth, or descendeth with the same in an Oblique. The formes of these is simple and of one kind only : because there can be but one position of a Right Sphære. But the later is various and manifold, according to the diverse Inclination of the same.

Now if you desire to know the Right Ascension or Descension of any Starre, for any time and place assigned: apply the same Star to the Meridian of your *Globe* : and that degree of the *Equator* that the Meridian crosseth at that situation of the *Globe*, will shew the Right Ascension and Descension of the same, and also divideth each Hemisphere in the midst at the same time with it.

And

And if you would know the Oblique Ascension or Descension of any Starre, you must first set the *Globe* to the latitude of the place, and then place the Starre at the Easterne part of the Horizon: and the Horizon will shew in the *Aequator* the degree of Oblique Ascension. And if you turne it about to the West side of the Horizon, the same will also shew in the *Aequator* the Oblique Descension of that Starre. In like manner may you find out the Oblique Ascension of the Sunne, or any degree of the *Eclipticke*, having first found out, in the manner wee have formerly shewed the place of the Sunne. And hence also may be found the difference of the Right and Oblique Ascension, whence ariseth the diverse length of dayes.

As for example. The Sunne entresth into Capricorne on the eleventh day of *December*, according to the old account. I would now therefore know the Right and Oblique Ascension of this degree of the *Eclipticke*, for the latitude of fiftie two degrees. First, therefore I apply the first degree of Capricorne to the Meridian: where I find the same to cut the *Aequator* at 270. gr. which is the degree of the Right Ascension. But if you set the *Globe* to the latitude of fiftie two degrees, and apply the same degree of Capricorne to the Horizon; you shall find the 303. gr. 50. m. to rise with the same. So that the difference of the Right Ascension 270. and the Oblique 303. gr. 50. m. will be found to be 33. gr. 50. minutes.

PONT.

PONT. This *Ascension* and *Descension* is also called the *Astronomicall rising* and *setting* of the *Stars*: and that in respect of the *Arches* and *parts* of the *Ecliptique*, or *Starres*, either above or beneath the *Horizon*. Now an *Arch* of the *Ecliptique* or *Zodiaque* is to bee understood two manner of wayes: namely *Continued*, or *Discrete*. A *continued Arch*, is when it is reckoned in the *Æquator* in a *continued Series* from the beginning of *Aries*, and so forward into the consequent *signes*. A *Discret Arch* is so called, because it is not reckoned from the first degree of *Aries*, but from any other point in the *Equator*: as if you should say, an *Arch* from the 14. gr. of *Gemini* to the 14. gr. of *Taurus*.

Beside, this *Right Ascension* is called also the greater *Ascension*, because that in it a greater *Arch* of the *Equator* riseth above the *Horizon*, then of the *Zodiaque*: and it is called *Right*, because that in this the *Angle* which is made by the *Horizon* and *Ecliptique*, is nearer to a *Right Angle*, then that is made by any other part of the *Ecliptique* with the same. And that is said to be a greater *Arch* or portion of the *Equator*, which is more than 30. degrees in the *Ascension* or *Descension*: and that is called a *lessor Arch*, which falls short of thirtie degrees in rising or setting.

In a *Right Sphere* foure *signes* onely ascend *Rightly*, which are *Gemini*, *Cancer*, *Sagittarius*, and *Capricornus*: all the rest ascend *Obliquely*.

In an *Oblique Sphere* sixe *signes* rise *Rightly*,
P and

and the other sixe Obliquely. The right are these, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius: and all the rest Obliquely.

Oblique Ascension, is when a lesse Arch or portion of the Equator riseth, then of the Zodiacque: or else, that Starre may be said to rise Obliquely, with whom a lesse portion of the Equator ascendeth above the Horizon. And so the Oblique descension or setting of a Starre is, where a lesse portion of the Equator descendeth with it. As for example. At Rome with the Arch of Libra, which containeth 30. gr. in the Zodiacque, there riseth an arch of the Equinoctiall of 37. gr. So that this signe is said there to rise rightly: Because that a greater Arch of the Equator ascendeth with it, then of the Zodiacque. But then at the same place with the Arch of Aries, there arise only 17. gr. of the Equator. Whence it followeth that Aries riseth Obliquely at Rome. In our position of Sphere also here at London, which is Oblique, like as that at Rome, with Libra there ariseth an Arch of the Equinoctiall containing about 41. gr. but with the Arch of Aries there ariseth not above 13. degrees. Therefore in our Sphere Libra ascendeth or riseth rightly, but Aries Obliquely.

Certaine Rules, for the Astronomicall rising in a Right Sphere.

THe Rules of Astronomicall rising in a right Sphere are these. 1. The whole Quadrants or quarters of the Zodiacque and Equinoctiall rise

rise and set in an equall space of time. 2. But the parts of the Quadrants rise and set unequally. 3. Those signes that are equally distant from any of these points, have also equall ascensions: as Gemini and Cancer. 4. The Ascension of a signe is alwayes equall to the Descension of the same. 5. Foure signes only rise rightly, namely Gemini, Cancer, Sagittarius and Capricornus: and all the rest obliquely.

Rules for the Astronomicall rising in an Oblique Sphere.

IN an Oblique Sphere, the two halves that begin at the two Equinoctiall points, doe rise together. 2. The parts of these halves doe rise unequally. 3. Those signes that rise rightly, descend Obliquely, and so contrarily. 4. The Ascension of any signe is equall to the Descension of the same. 5. The Ascensionall Arches of the Northerne signes are lesse then in a right sphere, but in the Southerne signes they are greater. 6. The Ascension of Opposite signes in an Oblique Sphere taken together, are equall to the Ascension of the same in a right Sphere. 7. Those signes that are equidistant from either of the Equinoctiall points, have equall Ascensions, because they decline equally from the Equator.

CHAP: VIII.

How to finde out the Horizontall difference betwixt the Meridian and the Verticall circle of the Sunne, or any other Starre, (which they call the Azimuth,) for any time or place assigned.

HAving first observed the Altitude of the Sunne, or Starre that you desire to know, set your *Globe* to the latitude of the place you are in: which done, turne it about, till the place of the Sun, or Starre which you have observed, be elevated so much above the Horizon, as the Altitude of the same you before observed. Now you shall find that you desire, if you take the Quadrant of Altitude, and fasten it to the Verticall point of the place you are in, and so move it together with the place of the Sunne or Starre up and downe, untill it fall upon that which you have set downe in your instrument at your observation. Now in this situation of the Quadrant, that end of it that toucheth the Horizon, will shew the distance of the Verticall circle, in which you have observed the Sunne or Starre to be, from the Meridian. As for example.

In the Northerne latitude of 51. gr. on the 11th. of *March* after the old account, at what time the Sunne entreth into *Aries*, suppose the altitude of the Sunne before noone to be observed

ved to be thirtie gr. above the Horizon. And it is demanded, what is the *Azimuth*, or distance of the Sunne from the Meridian. First therefore having set the *Globe* to the latitude of 51. gr. and fastening the Quadrant of Altitude to the *Zenith*, I turne the *Globe* about, till I finde the first degree of *Aries* to be 30. gr. above the Horizon. And then the Quadrant of Altitude being also applied to the same degree of *Aries*, will shew upon the Horizon, the *Azimuth* of the Sunne, or distance of it from the Meridian, to bee about fortie five degrees.

CHAP. IX.

How to find the boure of the day, as also the Amplitude of rising and setting of the Sunne and Starres, for any time or latitude of place.

THe Sunne, we see, doth rise and set at severall seasons of the yeare, in diverse parts of the Horizon. But among the rest it hath three more notable places of rising and setting. The first whereof is in the *Aequator*, and this is called his *Aequinoctiall* rising and setting. The second is in the Summer Solstice, when he is in the Tropique of *Cancer*: and the third is in the Winter Solstice, when hee is in the Tropique of *Capricorne*. Now the *Aequinoctiall* rising of the Sun is one and the same in every

Climate. For the *Æquator* always cutteth the *Horizon* in the same points, which are alwaies just 90. gr. distant on each side from the *Meridian*. But the rest are variable and change according to the diverse inclination of the sphere: and therefore the houres are unequall also.

PONT. And here you are to understand that the *Amplitude* of the *Sunnes* rising and setting, is an *Arch* of the *Horizon* intercepted betwixt the *Æquator*, and the place of the rising and setting of the *Sun*. And it is either *Northerne* or *Southerne*. The *Northerne Amplitude*, is when he sets and riseth on this side of the *Æquator*, toward the *North Pole*: and the *Southerne* when he sets or riseth on the contrary side. Now when the *Sun* is in the *Æquator*, he hath noe *amplitude* at all: but when hee is in the *Solsticiall* points, hee hath then the greatest *Amplitude* of all: of which that in the *Tropique* of *Cancer* is called the *Æstivall*, or *Summer Solsticiall Amplitude*; and the other the *Brumall*, or *Winter Solsticiall Amplitude*.

And here it is to be noted, that in all places the *Crtive Amplitude* of any *Starre* is equall to the *Occidentall Amplitude* of the same. And likewise that two *Starres* being equally distant from the *Æquator*, the one *Northward*, and the other *Southward*, or both of them *Northward*, or *Southward*, have equall *Amplitude* of rising and setting.

Now if you desire to know the *houre*, or *distance of time*, betwixt the rising and setting of the *Sunne*, when he is in either of the *Solstices*,

stices, or in any other intermediate place, and that for any time, or latitude of place: you shall work thus. First, set your *Globe* to the latitude of your place; then having found out the place of the Sunne, for the time assigned, apply the same to the Meridian, and withall you must set the point of the *Hour*-Index at the figure twelve in the *Hour*-circle. And having thus done, you must turne about the *Globe* toward the East part, till the place of the Sunne touch the Horizon: which done, you shall have the Amplitude of the Sunnes rising also in the *Equator*, which you must reckon, as we have said, from the East point, or place of intersection betwixt the *Equator* and Horizon. And then if you but turne the *Globe* about to the West side of the Horizon, you shall in like manner have the *hour* of his setting, and Occidentall Amplitude.

And if at the same time, and for the same latitude of place, you desire to know the *hour* and Amplitude of rising and setting, or the greatest elevation of any other Starre expressed in the *Globe*: you must turne about the *Globe*, (the Index remaining still in the same position, and situation of the Index as before) till the said Starre come to the Horizon, either on the East or West: and so shall you plainly have the *hour* and latitude that the Starre riseth or setteth in, in like manner as you had in the Sunne. And then if you apply the same to the Meridian, you shall also have the Meridian Altitude of the same Starre. An example

example of the Amplitude of the Suns rising and setting may be this.

When the Sunne enters into *Taurus*, (which in our time happens about the eleventh of *Aprill*, according to the *Julian* account) I desire to know, the houre and Amplitude of the Sunnes rising, for the Northerne latitude of fiftie one degrees. Now to finde out this, I set my *Globe* so, that the North Pole is elevated above the Horizon fiftie one degrees. Then I apply the first degree of *Taurus* to the Meridian, and the Houre-Index to the twelfth houre in the Houre-circle. Which done, I turne about the *Globe* toward the East, till that the first degree of *Taurus* touch the Horizon: and then I finde that this point toucheth the Horizon about the twentieth fift degree Northward from the East point. Therefore I conclude that to bee the Amplitude of the Sunne for that day. In the meane time the Index strikes upon halfe an houre after foure: which I take to be the time of the Sunnes rising.

CHAP. X.

Of the threefold rising and setting of Stars.

BEsides the ordinary Emerfion and Depression of the Starres in regard of the Horizon, by reason of the circumvolution of the Heavens: there is also observed a threefold rising and setting

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ting of the Starres. The first of these is called in Latine, *Ortus Matutinus*, *sive Cosmicus*, the Morning, or Cosmicall rising : the second *Vesperinus*, *sive Acronychus*, the Evening, or Acronychall : and the last *Heliacus*, *vel solaris*, Heliacall or Solar. The Cosmicall or morning rising of a Starre is, when as it riseth above the Horizon together with the Sunne. And the Cosmicall or morning setting of a Starre is, when it setteth at the Opposite part of heaven, when the Sunne riseth. The Acronychall or Evening rising of a Starre is, when it riseth on the Opposite part, when the Sunne setteth. And the Acronychall setting of a Starre, is, when it setteth at the same time with the Sun. The Heliacall rising of a Starre (which you may properly call the Emerision of it) is, when a Starre that was hid before by the Sunne beames, beginneth now to have recovered it selfe out of the same, and to appeare. And so likewise the setting of such a Starre (which may also fitly be called the Occultation of the same) is, when the Sunne by his owne proper motion overtaketh any Starre, so that by reason of the brightnesse of his beames it can no more be seene.

PONT. Concerning the rising, and setting of the Starres, which is considered in respect of the Horizon and Equator, hath beene spoken already in the seventh Chapter : where we also shewed, that that kind of rising and setting of the Starres was called Astronomicall. But in this place the rising of the Starres is considered in relation only

to the Horizon and Sunnes aspect, but not of the Equator; and therefore it is also commonly called, the Poëticall rising and setting of the Starres.

Now as touching the last of these kinds many Authors are of opinion, that the fixed Stars of the first magnitude do begin to shew themselves after their Emerision out of the Sunne-beames, when as they are yet in the upper Hemisphere, and the Sun is gone downe twelve degrees under the Horizon. But these of the second magnitude require that the Sunne is depressed 13. gr. and those of the third, require foureteene; and of the fourth, fifteene; of the fifth, sixteene; of the sixth, seventeene, and the cloudy and obscure Starres require eighteene degrees of the Suns depression. But *Ptolomy* hath determined nothing at all in this case: and withall very rightly gives this admonishment, *lib. 8. cap. ult. Almag.* that it is a very hard matter to set downe any determination thereof. For as he there well noteth, by reason of the unequall disposition of the aire, this distance also of the Sunne, for the Occultation and Emerision of the Starres, must needs be unequall. And one thing more we have to encrease our suspicion of the incertainty of this received opinion, and that is, that *Vsello* requireth nineteene degrees of the Suns depression under the Horizon, before the Evening twilight be ended. Now that the obscure and cloudy Starres should appeare ever, before the twilight be downe, I shall very hardly be persuaded

swaded to beleewe. Notwithstanding, how-
ever the truth of the matter be, we will fol-
low the common opinion.

Now therfore if you desire to know at what
time of the yeare any Starre riseth or setteth in
the morning or the evening in any Climate
whatsoever : you may find it out thus. First,
set your Globe to the latitude of the place you
are in, and then apply the Starre you enquire
after, to the Easterne part of the Horizon : and
you shall have that degree of the Eclipticke,
with which the said Starre riseth Cosmically,
and setteth Acronychally : and on the oppo-
site side on the West, the Horizon will shew
the degree of the Eclipticke, with which the
same Starre riseth Acronychally, and setteth
Cosmically. For the Cosmicall rising, and
Acronychall setting, and so likewise the Acro-
nychall rising, and Cosmicall setting of a
Starre are all one : according to those old
verses.

*Cosmicè descendit signum, quòd Acronychè
surgit.*

*Chronychè descendit signum, quòd Cosmicè
surgit.*

But these things are to be explained more
fully. For a Starre doth not alwayes rise and
set with the same degree of the Eclipticke.
For the Southerne Starrs doe anticipate the de-
gree with which they rise, at their setting :
but the Northerne Starrs come after it : that
is, if the elevation be of the Articke Pole.
Other-

Otherwise it is quite contrary, if the South Pole be elevated. Now having found the degree of the Eclipticke with which the Starre you enquire after, doth rise and set; if you seek for the same degree of the signe in the Horizon of your Globe, you shall presently have the moneth and day expressed, wherein the Sunne commeth to the same degree and signe.

And as for the Heliacall rising and setting of a Starre, you may find it thus. Having set your Globe to the latitude of your place, you must turne about the Starre proposed to the West side of the Horizon, and withall on the opposite East part observe what degree of the Eclipticke is elevated above the Horizon 12, 13, 14. or any other number of degrees, that the magnitude of your Starre shall require for distance from the Sunne. And when the Sun shall be in the Opposite degree to this, then that Starre will set Heliacally, that is to say, it will be quite taken out of our sight by the brightnesse of the Sunne-beames. Now if on the other side you apply the same Starre to the East, and find out the Opposite degree in the Eclipticke on the West part, that is, the same number of degrees above the Horizon: when the Sunne commeth to this place, the same Starre will rise Heliacally, or recover it selfe out of the Sunnes beames. And so if you but find the same degrees of the Eclipticke, among the Signes on the Horizon of your Globe, you have the Moneth and the day, when

when the Sunne will be in those degrees. And the same also is the time of the Emerſion and Occultation of the Starre you enquire after. But we will here propoſe an example of the Occultation of ſome fixed Starre of the firſt magnitude: which done, the Emerſion of the ſame is alſo found by the contrary way of working.

And the Starre we propoſe, ſhall be that bright Starre in the mouth of the Great Dog, which is called *Sirius*: whoſe Occultation we deſire to know for the Latitude of 51. gr. Northward. Now this Starre, being of the firſt magnitude, beginnes to bee hid, when as it toucheth the Horizon in the upper Hemisphere, and the Sunne is at the ſame time depreſſed under the Horizon but 12. degrees. If therefore you apply this Starre to the Weſt part of the Horizon (having firſt ſet your Globe to the latitude of 51. degrees) and on the Oppoſite Eaſt ſide, obſerve what degree of the Eclipticke is juſt 12. degrees above the Horizon (now this degree is very neare the 11. gr. of *Scorpius*) when the Sunne ſhall come to the Oppoſite degree in the Ecliptick, which is the 11. of *Taurus*, that Starre will ſet Heliacally, and be hid by the Sunne-beames. But the Sun comes to this degree of *Taurus* about the 22. of *Aprill*: therefore we conclude that the Dogge Starre ſets Heliacally about that time. And if you worke in the ſame manner, applying the Starre to the Eaſt part of the Horizon, you ſhall have the time of
its

its Heliacall rising or Emerſion out of the Suns beames.

Not unlike this is the manner of proceeding alſo in finding the beginning and ending of the twilights : of which we ſhall ſpeake in the next Chapter.

PONT. *The uſe and benefit of this diſcourſe concerning theſe kinds of riſing and ſetting of the Starres, is principally ſeene, in reading of the ancient Authors and Poets, eſpecially thoſe that have written of Huſbandry; and the ſeverall ſeaſons of the yeare. For ſo Virgil. lib. 1. Georg. makes mention of the Coſmicall riſing of the Starres in theſe verſes.*

Candidus auratis aperit cum cornibus annum.

Taurus, & adverſo cadens Canis occidit aſtro.

Which is thus Engliſhed by. T. May.

When with his golden hornes bright Taurus opes;

The yeare : and downeward the croſſe Dog-ſtarre ſtoopes.

In which place hee meaneth to intimate the moneth of April, when as the Sunne is in the ſigne Taurus, and riſeth with it. And we have an example alſo of the Coſmicall ſetting in the ſame place, where he ſaith.

*At ſi triticeam in meſſem, robuſtâq; farra
Exercebis humum, ſoliſque inſtabis ariſtis,
Antè tibi Eoæ Atlantides abſcondantur,
Gnoſiâque ardentis decedat ſtella coronæ,
Debita quàm fulcis cômittas ſemina, quàmq;
Invita*

Invitæ properes anni spem credere terræ.
Multi ante occasum Maiæ expere ; sed illos
Expectata seges vanis elusit avenis.

Thus rendred by T. May.

But if thou plough to some more solid graine,
A wheat or barley harvest to obtaine :
First let the morning Pleiades be set,
And Ariadne's shining Coronet,
Ere thou commit thy seed to ground, and there
Dare trust the hope of all the following yeare.
Some that before the fall'oth Pleiades
Began to sowe, deceived in the encrease,
Have reapt wilde oates for wheate, &c.

Where hee would have them to expect their
sowing time, till that the Altantides, that is, the
Pleiades, or seven Starres be hid in the East, that
is, in the Morning by the approach of the Sunne,
which is also called Occalus Cœsmicus. At
which time also the bright Starre in the North-
erne Crowne sets in the Evening with the Sun,
or Heliacally. And so the Poet by a twofold kind
of setting of the Stars, describes the 28. and 29.
of October.

An example of the Acronychall rising you
have in Ovid. lib. 1. de Ponto Eleg. 9. where
he describeth the tediousnesse of his exile, from the
Autummall or Vespertine rising of the Pleiades,
in these words.

Vt careo vobis Scythicas detrusus in oras ;
Quatuor Autumnos Plēias orta facit.

In English thus.

Since of your joyfull sight cold Scythia me depriv'd
The rising Pleiades foure Autumnos have reviv'd
And

*And he also mentioneth the Acronychall setting,
lib. 2. Factor: where speaking of the third of
February, he doth it by this Periphrasis.*

*Quem modo celatum stellis Delphina videbas,
Is fugiet visus nocte sequente tuos.*

That is to say.

*The Dolphin earst with Stars you saw bedight,
The next night vanisheth out of your sight.*

*An example of the Heliacall rising in February
you have in the same Author, in these words.*

*Tertia nox veniet, custodem protenus arce,
Aspicias geminos exeruisse pedes.*

Which may be Englished thus:

*When now the third night comes, you shall perceive
Arctophylax will both his feet up heave.*

*And for the Heliacall setting, you had an in-
stance above out of Virgil, Georg. 1.*

—Et aduerso cadens canis occidit astro.

*In which place the Poet speaketh of sowing
willet and beanes in the spring time. To these we
may also adde these severall kinds of Poeticall ri-
sing and setting of Starres exprest.*

Cosmicus est ortus, cum sol emergere quærit.

Ipsius oppositum lapsus, ad ima gerit.

Chronicus est lapsus, cum sol in vespere tabet.

Ipsius oppositum Chronicus ortus habet.

Heliacus signo datur ortus sole remoto.

Illius occasum proximitate noto.

CHAP. XI.

*How to finde the beginning and end of the
Twilight, for any time and Latitude of
place.*



He *Twilight* is defined to bee a kind of imperfect light betwixt the Day and the Night, both after the setting, and before the rising of the Sunne. Of which the first is called the *Evening Twilight*, and the other the *Morning*. Now the beginning of the one, and the ending of the other are perceived at the same equall space of time from the rising and setting of the Sun: notwithstanding the continuance of each of them is sometimes greater, and sometimes lesse. For in Summer the Twilights are much longer then in the Winter. The measure of them they commonly make to be, when as the Summe is depressed 18. degrees under the Horizon. But, as *P. Nonius* rightly observeth, there cannot be any certaine Measure or Terme assigned them, by reason of the various disposition of the aire, and the elevation of the vapours that are exhaled out of the earth; which the same Author saith, he findes to be also diverse, sometimes higher, and sometimes lower. *Vicellio*, and *Albarezus* before him, would have it to bee, when the Sun is depressed under the Horizon

nineteene degrees. But how ever the truth be, we shall follow the common received opinion herein. Now therefore if you desire to know upon these grounds here laid downe, at what houre the Twilight begins and endeth at any time or latitude of place; you must doe thus. First, set your *Globe* to the latitude of the place, and apply that degree of the *Eclipticke*, wherein the *Sunne* is at that time, to the *Meridian*, and withall direct the point of the *Index* to twelve in the *Houre-circle*: Then marking the degree of the *Eclipticke*, that is directly opposite to the place of the *Sunne*, turne about your *Globe*, till such time as the opposite degree of the *Sunne* be elevated eightene gr. above the *Horizon* toward the *West* part of it: and forthwith the *Index* will shew in the *Houre-circle* the beginning of the *Morning Twilight*. And if you turne about your *Globe* in like manner to the *East*, you shall also have the houre when the *Evening Twilight* orderth

P O N T. Our Northerne regions have their *meavayauis*, or *Twilight*, of above an houre long. But those Countries, where the *Tropicke* are very farre beneath their *Horizon*, have in a manner no *meavayauis*, no *Twilight* or breake of day. And therefore those that inhabite neare the *Aequator*, have not the beginning nor later part of the night enlightened at all, neither is there any appearance of light, before the *Sunne* bee risen. Whereas on the contrary side, those that have the *Tropicke* very neare their *Horizon*, must necessarily

richly have *Twilight* almost all the night long in Summer. And therefore when the Romans came into Britaine, and perceived that at the Summer Solstice their nights were light almost all the night long: they did not account this *Twilight* to be night, but said, *Minimâ nocte contentos Britannos*, that the Brittaines were contented with a very short night.

Now this *παρασημια*, as it is defined by Ioseph Scaliger upon Manilius, is nothing else, but *περιεως ἀντιστάσις*, a kind of *Antiperistasis*, or Circumstipation (as we may call it) of the light: which can be none at all in those places, where the Tropicke and Horizon are farre distant. For this *παρασημια*, as Scaliger in that place accurately observeth, is only found under those signes, which are neare the Solsticiall point, as Gemini and Cancer; and that in those Countreies too; where the night is somewhat longer, then it is under the Pole of the Eclipticke: as for example, (to use Scaligers owne words) those that have not the Tropicke for their Arcticke circle, nor yet it toucheth the North point of the Horizon; with them the night is so long darke, as while the Tropicke commeth to strike upon the North point of the Horizon. As we know it hapneth in Scotland, where our Countreymen that were Souldiers there, could see to play at dice all night long without any Candle, about the time that the daies were at the longest. Now the Tropicke is distant from the Horizon at Edenburg 9. gr. 17. m. or thereabout. And therefore so much is the distance betwixt the Sunne and their Horizon at midnight to

the Summer Solstice: so that necessarily the rest of the night must bee Twilight, and of 6. houres, 23. minutes, which is the length of their night, not above 37 m. which is not much above halfe an houre, are quite darke: and all the rest of the night is light. Whence you may perceive the reason of the long continuance of the day in those regions, that have the Tropicke neare bordering on their Horizon. And therefore the Romans being well acquainted with this Antiperistasis of the light, thought that in those parts they had had scarce any night at all. And hence it necessarily followes, that by how much the Tropicke is more remote from the Horizon, by so much are the nights less enlightened: and those that inhabits neare the Equinoctiall are so farre from having their day extended farther, either before the Sun rises, or after it sets, as that with them there is no appearance of light at all, before the Sun is up. And there is scarcely any Twilight or dawning of the Day at all, in those regions that lye within tenne degrees of the Equinoctiall: for which there can be no other reason given, but only the distance betwixt the Tropicke and their Horizon. And if they have n. Twilight in the Summer, how much lesse will there be any when the Sun is in the other Tropicke. So that we have no reason to give any credit to Aloysius Cadamustus, who when he had occasion to write of this argument, gave this to be the reason of it, because there are no mountains there to hinder, but that the Sun may be seen at the instant of his rising. But this is a ridiculous reason, and not worthy a confutation. Thus Scalliger.

CHAP. XII.

How to find the length of the Artificiall Day or Night, or quantity of the Sunnes Parallel that remaines above the Horizon, and that is hid beneath it, for any Latitude of place and time assign'd. As also to find the same of any other Starre.

The Day we have already shewed to be twofold; either Naturall, or Artificiall. The Naturall Day is defined by the whole revolution of the Equator, with that portion also of the same that answereth to such an Arch of the Eclipticke, which the Sunne passeth over in one day. Now the whole revolution of the Equator (besides that portion which answereth to the Sunnes proper motion) is divided into twentie foure equall parts, which they call equall houres: because they are all of equall length, fifteene degrees of the Equator rising, and as many setting every houres space. Now the beginning of this Day being diverse, according to the diversity of Countries, (some beginning it at Sun-set, as the *Athenians* and *Jews*: some at midnight, as the *Egyptians* and *Romanes*; others at Sunne-rising, as the *Chaldeans*; or at Noone, as the *Umbrians* and commonly our Astronomers doe at this day :) this being not a thing suitable to our present

purpose, I shall not proceed any further in the explanation of the same.

The *Artificiall day* is defined to bee, that space of time that the Sunne is in our upper Hemisphere: to which is opposed the *Artificiall Night*, while the Sunne remaineth in the lower Hemisphere. The *Artificiall day*, as also the *Night*, are divided each of them into 12. parts, which they call unequal houres: because that according to the different seasons of the year, they are greater or less, and are never alwayes of the same length.

The length of the *Artificiall day* is thus found out. The *Globe* being set to the latitude of the place, you must find out the degree of the Ecliptick that the Sun is in at that time; and apply the same to the Meridian, and direct the *Houre-Index* to the number of 12. in the Circle. And then turning about the *Globe*, till the place of the Sun touch the Horizon, the Easterne part, the *Index* will shew the houre in the Circle of the rising of the Sun; and if you but turne it about againe to the West, you shall in like manner have the houre of his setting, and so by this meanes find out the length of the *Artificiall day*. Now if you multiply the number of the houres by 15. (for so many degrees, (as we have already often said) are allowed to one equall *Æquinoctiall* houre) you shall presently have the number of degrees of the Suns Parallel that appeares above the Horizon: which if you subtract out of 360, the remainder will be the quantity of that part

of the same Parallel that alwaies is hid under the Horizon. Or else you may proceed the contrary way, and first finde out the quantity of the Diurnall Arch, and afterward by the same, you may gather the number of the houres also. For the *Globe* being set to the latitude of the place, and the degree of the Eclipticke that the Sunne is in being knowne, you may finde out, in the manner now set downe, the difference of the Right and Oblique Ascensions of the same degree of the Eclipticke, for the latitude of that place. For this difference will be the halfe of that, wherein the *Artificiall day*, for that time and place, is either deficient, or exceeds the length of our *Æquinoctiall day*. And therefore you must adde it, when the daies are longer then the nights, (which is from the 11th. of *March*, to the 12th. of *September* :) but subtract all other times of the year, when as the nights are longer then the dayes.

As for example. On the 12. day of *June*, according to the old account, the Sunne enters into *Cancer*: the Right Ascension of which degree of the Eclipticke is 90. degrees. But if in the latitude of 52. gr. the first degree of *Cancer* bee applied to the Horizon, wee shall finde the Oblique Ascension of it to bee fiftie sixe gr. and about tenne m. So that the difference betwixt them is 33. gr. 50. m. which if you adde to ninetic gr. the halfe of the *Æquinoctiall day*, the length of the *Artificiall day* will then bee 123. gr. fiftie m.

and the whole Diurnall Arch 247. gr. 40. m, which if you divide by fifteene, the quotient will be sixteene and almost an halfe : which is the number of houres in the Artificiall day on the twelfth of *June*, for the latitude of fiftie two degrees.

And by this meanes may you also finde out the quantity of the longest, or shortest, or any other intermediate day, together with the increase and decrease of the same, for any time or latitude of place.

Cleomedes would have the quantity of the dayes to increase and diminish after this manner: that the month immediately before and also after the *Æquinoxe*, the daies should increase and decrease the fourth part of the whole difference betwixt the length of the longest and the shortest dayes of the whole year: and the second moneth they should differ a sixth part; and the third a twelfth part: that is, if the whole difference betwixt the longest and the shortest day bee sixe houres. So that the moneth going immediately before, and after the *Æquinoxe*, the dayes increase and decrease an houre and an halfe, that is to say, the fourth part of 6. houres: the second month an whole houre; and the third month halfe an houre. But suppose we this to be exactly agreeable to some certaine determinate latitude; yet it is not generally so in all places. For according to the diverse Inclination of the Sphere, the daies also are observed to increase and decrease diversly. For seeing that the Parallels in every
severall

severall latitude are cut by the *Æquator* in a different manner, it must needs follow, that the proportion of the increase and decrease of the dayes must be also different.

I shall not here need to set downe the manner, how to find the apparent Arch of the Parallel of any Star; seeing that it is found out in the same manner, as the Diurnall Arch of the Sunnes Parallel is.

CHAP. XIII.

How to finde out the houre of the Day and Night, both equall and unequall, for any time and latitude of place.

IF you desire to finde out the equall houre of the Day, first set your *Globe* to the latitude of the place you are in: and also observe the latitude of the Sunne. Which done, apply the place of the Sunne to the Meridian, and set the Index to the twelfth houre in the Circle: and then turne about the *Globe* either to the East, or West, as your observation shall require, untill that the place of the Sunne be elevated so many degrees above the Horizon, as shall agree with your observation: as hath beene already shewed, in declaring how to find the *Azimuth*. And the *Globe* standing in this situation, the Index will point out in the *Hour-circle* the houre of the day, wherein your observation was made. After the same

same manner also you may finde the houre of the night, by observing the Altitude of any knowne Starre, that is exprest in the *Globe*. For the Index must stand still, as it did before, when it was fitted to the place of the Sunne: and the *Globe* must bee turned about, till the Starre be observed to have the same Elevation above the Horizon of the *Globe*, as it had in the Heavens, and then the Index will shew the houre of the Night.

Now the manner how to find out the un-equall houre of the day, is this. First you are to find out, as we have already shewed, the quantity or number of the houres of the *Artificiall day*, and also the equall houre of the same: whence by the rule of proportion, you may also come to the knowledge of the un-equall houre.

PONT: *The un-equall houres doe answer to the Artificiall day, which, (as you have heard before,) is defined to be the space of time that the Sunne remains in the upper Hemisphere: to which is opposed the Artificiall night, comprehending all that time, while the Sun is hid from us. Which space of time, seeing that it is alwayes divided into 12. parts, (which they call un-equall houres:) the day it selfe being at diverse seasons of the yeare of different length, the houres it containes must also be un-equall. So likewise on the other side, the equall houres doe agree to the Naturall day, which is defined by the whole and perfect revolution of the Equator: And this also is divided into 24. equall parts, which are therefore called equall houres, because*

cause they are alwayes of equall length, fifteene degrees of the *Equator* rising and setting every houre. For the whole *Equator* being divided into 24. parts, there are contained in the revolution of it 15. parts of time, which is the measure of an houre: so that an equall houre is the 24th. part of the whole *Equinoctiall* circle.

In the latitude of 49. degrees, the longest day containeth 16. houres. Now therefore when it is 10. of the clocke before Noone, or the sixth houre after Sun-rising on this day, I desire to know, what unequal houre of the day it is. I therefore dispose my proportionall tearmes thus, 16. give 6. therefore 12. (which is the number of equall houres in every day or night) give 4. and an halfe.

And if wee desire to know, how many degrees of the *Equator* doe answer to one unequal houre; we may doe it thus: namely by dividing the whole number of degrees of the Diurnall Arch by 12. As if the *Artificiall* day bee 16. equall houres in length, then the Arch of the Diurnall Parallel will be 240. degrees. Which if we divide by 12. the quotient, which is 20. will shew the number of degrees in the *Equator* that answer to one unequal houre. The like method also is to be observed, in finding out the length of the unequal houre of the Night.

CHAR.

CHAP. XIV.

To finde out the Longitude, Latitude, and Declination of any fixed Starre, as it is expressed in the Globe.

THE Longitude of a Starre, is an Arch of Eclipticke intercepted betwixt two of the greater Circles, which are drawne thorough the Poles of the Eclipticke, the one of which passeth through the intersection of the Equator and Eclipticke, and the other through the Center of the Starre.

The Latitude of a Starre, is the distance of it from the Eclipticke; which is also to be reckoned in that circle which passeth through the Center thereof.

Now if you desire to find out either of these, you must take the Quadrant of altitude, or any other Quadrant of a Circle, that is but exactly divided into 90. parts: and lay one end of it on either Pole of the Eclipticke, either Northern or Southerne, as the latitude of the Star shall require. Then let it passe through the Center of the Starre to the very Eclipticke, and there the other end will shew the degree of longitude of the same, which you must reckon from the beginning of *Aries*: and so that portion of the Quadrant that is contained betwixt the Starre it selfe and the Eclipticke,

ticke, will also shew the latitude of the Starre.

PONT. The manner how to finde the longitude and latitude of Starres, may bee shewed by this example. First, let us propose the head of Medusa, which is found in the tables to bee in the twentieth one gr. 8. and it hath in Northerne latitude twentieth three degrees. Now therefore in the superficies of the Globe wee must looke for the signe 8. and reckon 21. gr. from the beginning of the same on the Eclipticke: And the circle that shall be drawn from the Pole of the Eclipticke through this degree, shall bee called the circle of longitude of the head of Medusa. After this reckon the latitude of the Starre also in the same circle among the Parallels of latitude, beginning from the Eclipticke, and so forward toward the Articke Pole, (because the latitude of it is Northerne,) untill you have accounted 23. gr. which is the number of the degrees of latitude, and sheweth the place of that Starre.

Now because that all the circles of longitudes and latitudes neither are, nor indeed can conveniently bee expressed on the Globe: therefore the Quadrant of altitude is to serve in stead of the same, for the finding out of the longitudes and situations of the Starres that are set up the Globe: and that after this manner. Let us take our former example of Medusa's head: the latitude of which being Northerne, I apply the end of the Quadrant to the North Pole of the Zodiacus: (otherwise had it bene Southerne it must have been fixed to the Southerne Pole:) which done, I seeke

in the Eclipticke for the 21. gr. of Taurus, which is the longitude of the Starre; and having found it, I lay the other end of my Quadrant over it. For by this meanes the Quadrant shall supply the office of the circle of longitude of Medusa's head. Now therefore if I reckon 23. degrees on the said Quadrant, beginning from the Eclipticke, I shall have the true situation of this Starre in the Globe.

In like manner may we finde, by a Globe that hath the Starres described on it, the longitude and latitude of any Starre in the heavens. For if we fit the Quadrant to the Notherne Pole of the Zodiacque (if the Starre have Northerne latitude) and then let it passe through the center of any Starre: the degree of the Eclipticke that the other end of it shall point out, will be the longitude of the said Starre; and the degrees that are contained betwixt the Eclipticke and the Starre, will shew you the latitude of the same. As for example, if the Quadrant being first applied to the Northerne Pole of the Zodiacque, be afterward laid along over the bright Star in the Crowne; the other end of it will fall on the 6. gr. m. which is the longitude of this Starre. And then if you reckon the number of degrees betwixt the Eclipticke and the same Starre, you shall finde them to bee 44½. gr. which is the Northerne latitude of the same.

The Declination of a Starre, is the distance of it from the Equator: which distance must bee reckoned on a greater circle, passing through the Poles of the Equator. And there-

therefore if you but apply any Starre to the Meridian, you shall presently have the Declination of it, if you account the degrees and minutes of the Meridian (if there be any) that are contained betwixt the Center of the Starre and the Equator.

PONT. The Declination of Starres, as also their Right Ascension, may bee knowne by the Globe in this manner. The Starre proposed must be applied to the Meridian, and forthwith the same Meridian will discover, among the degrees of the Equator, the Right Ascension of the same: and it will also give you the Declination, if you reckon upon it the number of degrees that are comprehended betwixt the Equinoctiall and the Starre proposed. And for an example of this, let us propose the Great Dogge, whose Right Ascension and Declination wee desire to know. First, therefore we set the Starre it selfe directly under the Meridian, and find the Meridian to cut the Equinoctiall at 97. gr. 15. m. And this is the right Ascension of this Star. And then reckoning the number of the degrees comprehended betwixt it and the Equinoctiall Southward: we find them to be 16. degrees, which wee conclude to bee the Southerne latitude of this Starre.

The same also may be demonstrated by the Sun. For when the Sunne is in the 3. gr. of Gemini, he is carried under the Meridian, which crosseth the Equinoctiall about the 63. gr. reckoning from the first degree of Aries in the Equator. And this is the Ascension of the Sunne when he is in the 3. degree of Gemini. Now the number of the
degrees

degrees that are comprehended betwixt the place of the Sun and the Equator, being reckoned in the Meridian, are found to be 21. which is also the Suns Declination, and that Northward, because it falleth among the Northerne signes.

The same may be performed also after another manner, as thus for example. The right Ascension of the bright Star in the Crowne is found in the Astronomicall Tables to be 275. gr. 31. m. and the Declination of it Northward 38. gr. 26. minutes. First therefore I reckon the degrees of Right Ascension in the Equinoctiall, beginning at the first degree of Aries; and having found the degree, I apply it to the Meridian, in which I afterward reckon the Declination assigned, beginning from Equinoctiall, and proceeding toward the Arcticke Pole, if the Declination of the Starre be Northerne; if otherwise, toward the Antarctique.



A Table representing the Longitude, Latitude, Right Ascension, and declination of some certaine Notable STARRS.

The names of the Stars.	Longitude.			Nor. Sou.	Right Ascension.	Declination.		Nor. Sou.
	Deg.	Min.	D. M.			Deg.	Min.	
The first Star in the Rams Horne.	V	18	0 7	30	Nor.	10	0 18	0 Nor.
The 1. horse in the waine.	m	3	30 53	30	Nor.	188	10 57	27 Nor.
The 3. horse.	m	21	10 54	0	Nor.	201	24 52	3 Nor.
The head of the Dragon.	2	18	0 75	30	Nor.	226	8 58	8 Nor.
Bootes left shoulder.	11	18	0 40	0	Nor.	212	50 40	0 Nor.
Arcturus.	18	30	31	30	Nor.	109	17 21	53 Nor.
The bright Starre in the Crowne.	m	6	0 44	30	Nor.	229	0 38	25 Nor.
The head of Hercules.	2	9	0 37	30	Nor.	153	52 15	26 Nor.
The bright Starre of Lybra.	v	8	40 62	0	Nor.	275	32 38	36 Nor.
The Taile of the Swanne.	x	0	30 63	0	Nor.	307	20 44	23 Nor.
The Swannes bill.	v	25	50 49	30	Nor.	288	40 27	12 Nor.
Cassiopeia's breast.	8	2	10 46	45	Nor.	2	23 54	26 Nor.
The Goat.	II	16	20 53	30	Nor.	71	18 45	7 Nor.
The right side of Perseus.	8	27	0 50	0	Nor.	49	0 48	6 Nor.
Medusa's head.	8	28	8 33	0	Nor.	41	0 30	0 Nor.

The names of the Stars.	Longitude Deg. Min.	Latitude D. M.	Nor. Sou.	Right Ascension Deg. Min.	Declination Deg. Min.	Nor. Sou.
Andromedas head.	16	40	30	Nor. 357	0 27	0 Nor.
The Star in the end of Pegasus wing	9	0	34	Nor. 358	20 13	0 Nor.
Pegasus shoulder.	15	0	41	Nor. 341	11 13	0 Nor.
The Eagle.	25	10	29	Nor. 292	40 7	57 Nor.
The head of the Serpent- bearer.	16	10	38	Nor. 288	32 13	5 Nor.
The bulls eye	4	0	5	Nor. 63	0 15	54 Nor.
Castor	14	40	9	Nor. 107	0 32	30 Nor.
Pollux.	18	0	6	Nor. 110	20 18	30 Nor.
The Lions Heart.	23	50	0	Nor. 146	13 13	45 Nor.
Specta Virg- nis.	18	0	2	Sou. 195	46 8	55 Sou.
The South ballance of Libra.	9	20	0	Sou. 217	8 14	0 Sou.
The heart of the Scorpion	4	34	4	Sou. 241	41 25	30 Sou.
The tale of Capricorne.	20	0	4	Sou. 319	18 18	5 Sou.
Aquarius Thigh.	3	0	7	Sou. 337	47 17	24 Sou.
The Whales Taile.	27	0	20	Sou. 5	42 19	46 Sou.
The Whales Nostrils.	9	0	7	Sou. 40	32 2	47 Sou.
The Right shoulder of Orion.	3	20	17	Sou. 83	34 6	16 Sou.
The left foot of Orion.	10	30	31	Sou. 73	15 9	10 Sou.
The lesser Dog.	10	30	16	Sou. 109	43 5	53 Sou.
The great Dog.	9	0	9	Sou. 97	15 15	56 Sou.

CHAP. XV.

To finde the variation of the Compaſſe, for any Latitude of place.

THat the Needle touched with the Loadstone; doth decline in diverse places from the Interfection of the Meridian and Horizon, is a thing most certaine, and confirmed by daily experience. Neither is this a nicere forgery of Mariners, intended by them for a cloake of their own errors: as *P. De Medina*, Grand Pilot to the King of *Spaine* was of opinion. Neither yet doth it so come to passe, by reason that the vertue of the Magnet by long use and exercise is weakened; as *P. Nonius* conceived: or else because it was not originally endued with sufficient vertue: as some others coldly conjecture: but this motion proceeds from its owne naturall inclination. The cause of this deflexion; although hitherto in vaine sought after by many, hath yet beene found by none. In this, as in all other of Natures hidden and abstruse mysteries, we are quite blind. There have beene some that have endeavoured to prescribe some certaine Canon, or rule for this Deflexion, as if it had beene regular and governed by some certaine order: but all in vaine. For that it is inordinate and irregular, is testified by daily experience; not only such as is taken from the dull conjecture

of the common sort of Mariners, which oftentimes falls farre wide of the truth : but from the farre more accurate observations of skilfull Navigatours.

At the Isles, which they call *Azores*, it declineth not at all from the true Meridian : as the common opinion of Mariners is. And I dare bee bold to affirme, that at those more Western Islands also, it varieth very little or nothing at all. But if you saile Eastward from those Islands, you shall observe that point of the Needle that respects the North, to incline somewhat toward the East. At *Antwerpe* in *Brabant* it varieth about nine degrees : and neare *London* it declineth from the true Meridian above eleven degrees. And if you saile Westward from those Islands, the Needle also will incline toward the West. About the Sea Coasts of *America*, in the latitude of thirtie five, or thirtie sixe degrees, it declineth above eleven gr. from the true Meridian. Beyond the *Æquator* it happens cleane otherwise. Neare the outwardmost Promontory of *Brasile* looking Eastward, which is commonly called, *C. Frio*, it varieth from the true Meridian above twelve degrees. Within the most Eastward parts of the Straites of *Magellane* it declineth five or sixe gr. And if you saile from that Promontory, we now spoke of, toward *Africke* Eastward, the variation still encreaseth, as farre as to 17. or 18. degrees : which (as farre as

we can conjecture) happens in a Meridian not farre from that which passeth through the *Azores*. From thence the deflexion decreaseth to nine or tenne *gr.* which happeneth neare the Isle of Saint *Helen*, bearing somewhat toward the West. And from hence they say it decreaseth, till you are past the *Cape of good hope*, where they will have it to lye in the just situation of the true Meridian, neare to a certaine River, which for this cause is called by the *Portugals*, *Rio de las Aguas*. And all this deviation is toward the East.

All this wee have had certaine proofe and experience of, and that by as accurate observations as those instruments, which are used in Navigation, would afford, and the same examined and calculated according to the doctrine of Spharicall Triangles. So that we have just cause to suspect the truth of many of these traditions, which are commonly delivered, concerning the deflexion of the Needle. And namely whereas they report, that under that Meridian which passeth through the *Azores*, it exactly respects the true Meridian; and that about the Sea coasts of *Brasil* the North point of the Needle declineth toward the West, (as some affirme) we have found this to bee false. And whereas they report that at New-found land it declineth toward the West above 22. degrees: we very much suspect the truth hereof: because that this seemes not at all to agree with the observation we have made

concerning the variation about 11. degrees, neare upon the coasts of *America*: of the truth of which I am so confident, as of nothing more. It therefore appeares to be an idle fancy of theirs, who look to find some certaine point which the Needle should alwayes respect; and that either on the earth, (as namely some certaine Magneticall mountaines, not far distant from the Arcticke Pole,) or else in the Heavens, as (namely the taile of the little Beare, as *Cardan* thought:) or else that it is situate in that very Meridian that passeth through the *Azores*, and about sixteene degrees and an hialfe beyond the North Pole: as *Marcator* would have it. And therefore there is no heed to be taken to them neither, who conceive that there might be some certaine way found out of calculating the longitudes of places by means of this deflexion of the Needle: which I could wish they were able to performe: and indeed it might bee done, were there any certaine point that it should alwayes respect.

But to leave this discourse, let us now see, how the quantity of this declination of the Needle may bee found out by the use of the *Globe*, for any place of knowne latitude. And first you must provide you of some instrument, by which you may observe the distance of the Suns *Azimuth* from the situation of a Needle, Our Mariners commonly use a Nautical Compass, which is divided into three hundred fixtie degrees, having a thread placed cross-
wise

wise over the center of the Instrument to cast the shadowes of the Sunne upon the center of the same. This instrument is called by our Mariners, the Compasse of variation: and this seemeth to bee a very convenient instrument for the same use. But yet I could wish that it were made with some more care and accuratenesse, then commonly it is.

With this, or the like instrument, you must observe the distance of the Sunnes *Azimuth*, for any time or place, from the projection of the Magneticall Needle. Now we have before shewed, how to find out, how much the verticall circle of the Sunne is distant from the true Meridian. And the difference that there is betwixt the distance of the Sunne from the true Meridian, & from the situation of the Needle, is the variation of the Compasse. Besides, we have already shewed, how the Amplitude of the rising and setting of the Sunne may bee found. If therefore by the helpe of this, or the like instrument, it be observed, (as wee have said) how many degrees the Sunne riseth or setteth from those points in the Compasse, that answer to the East or West: you shall in like manner have the deviation of the Needle from the true Meridian, if it have any at all;

PONT. *At the end of this Chapter, I thinke it not amisse to set downe, that which Ioseph Scaliger, sometime upon occasion offered, wrote unto David Rivaldus, concerning the declination of the Magneticall Needle from the true Meridian. This Epistle of his is extant among those*

Epistles that were set forth at Paris with some other of his workes, Anno 1610. And because that there is something in the same that concernes the controversie of the Precession of the Equinoctiall points; I will set downe very neare the whole Epistle: and thus it is. *Literas tuas cum maxima voluptate, &c.*

Your Letters I have received, and read with very great satisfaction and delight: wherein I perceived two things chiefly to bee insisted upon: Which were, the Declination of the Magneticall Needle; and the Precession of the Equinoctiall points. In my former Letters I made mention indeed of the same, but with an intention rather to discover the opinion of others, then to proclaime mine owne. For I onely made a bare proposall of the matter, and no dogmaticall Position: that so, if the said declination bee to bee examined by the Meridians, and the Meridians, according to my Hypothesis, be moveable; that then our Astronomers and Navigators should see, whether or no, there might not some cause and reason of this so manifest disagreement bee discovered, out of this Essay of mine. For I would not have proposed it only, had I beene certainly assured of it: but would rather have endeavoured to make it appeare by demonstration. Whether therefore that be the cause of it, which I desire should be searched for out of my Hypothesis; or whether it be some other, it shall be all one to me. But the investigation of the Meridians is not sufficient for this matter. For

we must first dispute concerning the nature of the Magnet, whether or no it bee the property of it, alwayes to respect the North point: and if so, yet seeing that it declines from the Tearme proposed so many degrees, wee are next to enquire, whence this Variation proceeds: which certainly can be assigned to no other thing, then to the Meridians. But that we may not urge this question any farther: we must consult with those Authors that have written of the Magnet; and especially with William Gilbert of Colchester, a Philosopher and Practitioner of Physicke in London, who about three yeares since put forth three large bookes of the same subject: wherein he hath discovered to me his owne learning rather, then the nature of the Magnet. For now I am more in doubt, then before. The other part of your Letter is, concerning the Precession of the Equinoctiall points. It was observed first of all by Hipparchus, out of the observations of the fixed Starres of Aristarchus Samius, Conon, and Timochareis, that the Equinoctiall points were gone forward into the precedent parts; because that hee had found that the foure points (Equinoctiall and Solsticiall) were farther off from the Starres assigned for the same, then they were in the time of those Astronomers. Which when hee saw, hee doubted not forthwith to affirme, that the Equinoctiall points were immovable, and that the Sphere of the fixed Stars was gone backe into the succeeding parts. And hee did not perswade himselfe only to this, but even Ptolomy also; and Ptolomy all that came after him,

so

So great is the power of Prejudicate Authority. And he also rectified the Globe, and made the taile of the little Beare to bee distant from the Pole twelve gr. twentie foure m. choosing rather to beleve it so bee so, then to consult with the Starres to see whether it were so indeed, or no. Which thing I cannot sufficiently wonder at in him; seeing that not onely in his time, but also two hundred and eightene yeares before him, the taile of the lesser Beare was no farther from the Pole of the world, then it is at this day: as Eudoxus observed. Which I have most plainly demonstrated in my booke of the Præcession of the Aequinoctiall points. Besides, Eratosthenes also, who wrote one hundred twenty eight yeares after Eudoxus, affirmeth the same of the same Starre: and so did those that wrote in Augustus his time. If therefore two hundred and eightene yeares before Hipparchus time that Starre was where it is now; how then can that position of Hipparchus stand, who placed it 12. gr. 24. m. of the Pole of the world? For if the Sphere of the fixed Starres laid more backward into the succeeding parts, (as hee would have it) and that in his time the Taile of the Cynosure was 12. gr. 24. m. distant from the Pole: it necessarily followes, that in Eudoxus time it must have beene farther distant from the Pole, by 13. or 14. gr. For this is the proportion of degrees required for that motion. But it was then no farther distant, then it is at this day: and therefore Hipparchus hath abused both himselfe, and all that have come after him. And indeed

indeed I my selfe have made a collection out of him, of all the risings and settings of the Starres: which no man shall ever be able to understand, except he first make such a Globe, wherein the taile of the Cynosure shall be 12. gr. 24. m. distant from the Pole. Which thing when I imparted to that great Astronomer Tycho Brahe, he was amused and wondred very much at the novelty and strangenesse of the thing: and indeed not without cause. For I did not speake a word to him of the construction of Hipparchus his Globe, and the distance of the Cynosure from the Pole of it. And therefore we plainely see, that for as much as this Starre keeps the same distance from the Pole at this day, that it did 1967. yeares since, there is no motion at all of the eighth Sphere into the succeeding parts, but of the Equinoctiall points into the precedent. For of the motion there is no doubt at all to be made: for at this time the Equinoxe falleth before the first Starre in Aries above 28. gr. which notwithstanding in Eudoxus his time happened at the very Starre.

But now whether the Starre hath left the Sun behind it, or the Sunne the Starre, is the principall matter in question. For it must needs bee that one of them must stand still, and the other move: but wee have already shewed that the Starres are immovable: and therefore the Sun, and Equinoctiall points are moveable. And indeed they have manifestly gone forward since Eudoxus time 28. degrees.

This Copernicus (that great Scholler, and second Ptolomy of our age) perceived, when he
spake

spake these words. Vos putatis, &c. You thinke
 (saith hee) that the eighth Sphere moveth in-
 to the consequent parts : but consider whether
 the Equinoctiall points doe not rather move
 forward. Whence it appeares, that this never
 sufficiently commended man concluded, that there
 was a PraceSSION of the Equinoctiall points, and
 not a motion of the eighth Sphere into the subse-
 quent parts. For one of these being granted,
 the other must necessarily bee taken away: for
 if the eighth Sphere doth not move backward,
 the Equinoctiall points must necessarily move
 forward. And therefore herein Copernicus
 conjectured aright. But he omitted the chuf-
 est matter of all, either because perhaps hee
 perceived it not, or else despaired of ever being
 able to demonstrate it. For seeing that the
 Equinoctiall points are Moveable, it must
 needs follow, that a greater Circle described by
 the same must bee Moveable also, by the twen-
 tie Spharic. Element. And if the Circle be
 Moveable, the Pole must also be Moveable.
 And therefore the Pole of the Equinoctiall is
 not the same with the Pole of the world : for
 this is Immoveable, but the other Moveable : and
 so consequently all the greater Circles passing
 through these Poles, which are the Meridians,
 are also Moveable. So that Sunne-dials, and all
 Sciotericall instruments, that are placed upon a
 Meridian line, after some certaine tearme of years,
 must necessarily be defective: because the line it
 selfe is removed from its former situation. Of
 which variablenesse wee have observed notable
 arguments

arguments in monuments of Antiquity. These things it did concerne Copernicus either to have seene, or demonstrated, who was the first man that ever rejected that fabulous and ridiculous motion of the eighth Sphere, and withall proposed this opinion of the Praceession of the Equinoctiall points: Who, had hee but seene those things, which wee have observed historically out of the writings of the Ancient Astronomers, so great was the ingenuity of the man, that hee would have instantly consented, and demonstrated the matter Mathematically; which certainly is no hard matter to doe. For is there any man so void of all reason and judgement, as having granted the Equinoctiall points to be Moveable, to deny that a great Circle described by the same, must necessarily be Moveable also: and if so, that the Poles are also Moveable: and againe this being granted, that the Meridians are so too? He that shall deny this, I cannot see, what it hath profited him to have studied the Mathematickes.

But you will Object, that the Meridians are not changed, because they passe through the Poles of the world, which are Immuttable.

But then you have forgotten our Hypothesis, which is, that the Poles of the Equinoctiall are not the same with the Poles of the world. For these are Immuttable, but those other Mutable. And therefore we see the necessity of this Argument; and withall that these things being so, we are yet very farre

farre to seeke in many things necessary for the situation and construction of the Sphere. For by this reckoning it followeth necessarily, that the Equinoctiall circle should not bee described directly Parallel to the Pole of the world: and many other things of this nature; which might hence be concluded, I might willingly omit, because I speake to a Mathematician, who might better teach in these things. Wherefore I thinke I may boldly say, that none can be so impudent as to deny these things which are so manifest, as that we can prove them not only Historically, but also Apodictically, by certaine demonstration. And it behoves you to see and examine more narrowly whatsoever hath beene written by Mathematicians concerning this matter. For there is now no place left of denyall, but rather to see, how these things may be better demonstrated, and this done, the construction and position of the Sphere corrected. But I doe not speake this to the common sort of Astrologers, who never have read any thing but the Theorises of the Planets, and never so much as saw any of the Ancient Writers: unto whom, although they should perhaps have recourse, they could not understand.

Now as concerning the motion of Trepidation, it is long since exploded: and for Copernicus his motion of Libration, which is also a very vaine conceit, and I shall speake more of it hereafter, and shew whence this so idle a dream should possesse so worthy a man: for it differeth not much from that imposture of Trepidation. And as the truth hath at length got place, and removed.

removed that fabulous motion of Trepidation : so wee doubt not but necessity will at the last send after it this motion of the eighth Sphere also.

This therefore is the summe of our answer : that we desire, that the skilfull Artists would consider, whether the knowledge of the variation of the Magneticall Needle may be illustrated by those things which we have delivered concerning the Mutability of the Meridians : That there is no motion of the eighth Sphere into the consequent parts : That we are the first that have demonstrated the same : and that from thence must necessarily follow the Præcession of the Equinoctiall points. And this being granted, that then the Equinoctiall points, Equinoctiall circles, and their Poles, and Meridians passing through them are also moveable : and their Poles also different from the Poles of the world. And that the situation of Sunne Dials doth vary after some tearme of yeares : and that we are the first that observed the history of this notable peece of Antiquity ; which also may be demonstrated out of the Mathematickes. This is my opinion, which I will ever defend. But doe you consider better of it : and in the meane time Farewell. Lug. Bat. 26. Kal. Mai. An. 1604.

And this is Scaligers Epistle, in which where- as he speaketh of three bookes of the Magnes, written by W. Gilbert, it seemes to be a slip of his memory : for the same Author wrote, not three, but sixe bookes de Magnete, which were printed at London by Peter Short, An. 1600.

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the fourth and fifth bookes whereof doe especially handle the doctrine of the variation of the Compasse. And whereas he addeth, that himselfe had plainly demonstrated in a certaine booke of his, that the Taile of the Cynosure had the same situation anciently, that it hath at this day; he meaneth that booke which beareth title, *Diatriba de Equinoctiorum Anticipatione*, and was printed at Paris, An. 1613. Which booke I understand since, that Iohannes Maginus a Paduan, and professor of the *Mathematiques* in Bononia, hath undertaken to confute: as appears by the Catalogue of bookes in the year 1617. where there is mention made of the same Confutation printed at Rome, by Andrew Brugiotti; and at Colen, by Antony Hierat, in quarto. In which booke the Author takes upon him to impugne certaine new Tenets, concerning the Polar Starre, and the mutation of the Equinoctiall points, and immobility of the fixed Starres: with diverse Astronomical matters, which the title promiseth: notwithstanding it hath not yet beene my good hap, though I have made very diligent enquiry, to meet with any of these bookes.

CHAP. XVI.

*How to make a Sunne Diall by the Globe,
for any Latitude of place.*



We do not here promise the whole Art of Dialling: as being a matter too prolix to be handled in this place, and not so properly concerning our present business in hand. And therefore it shall suffice us to have touched lightly, and as it were, pointed out only some few grounds of this Art: being such as may very easily bee understood by the use of the Globe.

And here in this place wee shall shew you only two the most common sorts of Dials: one whereof is called an *Horizontall* Diall, because it is described on a Plane or flat, which is Parallel to the Horizon: and the other is called a *Murall*, as being erected, for the most part, on a Wall, perpendicular to the Horizon, and looking directly either toward the North, or South. But both these may not unfitly bee called *Horizontall*: not in respect of the same place indeed, but of diverse. And therefore whether it be a Flat Horizontall, or Erect, or else Inclining any way: there will be but one kinde of Artifice in making of the same.

Let us therefore now see in what manner a
3 plane

plaine Horizontall Diall may be made for any place. Having therefore first prepared your flat Diall Ground Parallel to the Horizon, draw a Meridian on it, as exactly North, and South as possibly you can. Which done, draw another East and West, which must crosse it at right angles. The first of which lines will shew twelve, and the other sixe of the Clocke, both morning and evening. Then making a Center in the Interfection of these two lines, describe a circle on your Diall Ground to what distance you please: and then divide it, (as all other circles usually are) into 360. parts. And it will not be amisse to subdivide each of these into lesser parts, if it may conveniently be done. And now it only remaines to finde out the distances of the Houre-lines in this circle, for any latitude of place. Which that we may doe by the use of the *Globe*, let it first be set to the latitude of the place assigned. And then make choice of some of the greater circles in the *Globe*, that passe through the Poles of the world; (as for example, the Equinoctiall Colure, if you please:) and apply the same to the Meridian: in which situation it sheweth midday, or twelve of the Clocke. Then turning about the *Globe* toward the West, (if you will) till that fiftene degrees of the Equator have passed through the Meridian: you must marke the degree of the Horizon that the same Colure Crosseth in the Horizon. For that point will shew the distance of the first and eleventh houres from the Meridian. Both
of

of which are distant an houres space from the Meridian, or line of midday. Then turning againe the *Globe* forward, till other fifteene degrees are past the Meridian; the same Colure will point out the distance of the tenth houre, which is two houres before Noone, and of the second houre after-noon. And in the same manner you may finde out the distances of all the rest in the Horizon, allotting to each of them fifteene degrees in the *Equator* crossing the Meridian. But here you must take notice by the way, that the beginning of this account of the distances, must bee taken from that part of the Horizon, on which the Pole is elevated: to wit, from the North part of the Horizon, if the Arcticke Pole bee elevated; and so likewise from the South part, if the Antarcticke be elevated.

These distances of the houres being thus noted in the Horizon of the *Globe*, you must afterward translate them into your Plaine allotted for your Diall Ground, reckoning in the circumference of it so many degrees to each houre; as are answerable to those pointed out by the Colure in the Horizon. And lastly, having thus done, the Gnomon or Stile must bee erected. Where you are to observe this one thing (which is indeed in a manner the chiefe and onely thing in this Art to bee carefully looked unto) namely, that that edge or line of the Gnomon which is to shew the houres by its shadow,

in all kinds of Dials must be set Parallel to the Axis of the world : that so it may make an Angle of Inclination with its plaine ground, equall to that which the Axis of the world makes with the Horizon. Now that the Stile is to stand directly to the North and South, or in the Meridian line, is a thing so commonly knowne, that it were to no purpose to mention it. And this is the manner of making a Diall on a plaine Horizontall Ground.

Now if you would make a plaine Erect Diall perpendicular to the Horizon (which is commonly called a *Murall*) and respecting either the North or South : you must remember this one thing : (the ignorance whereof hath driven those that commonly profess the Art of Dialling into many troubles and difficulties :) this one thing, I say, is to be observed : that that which is an Erect Diall in one place, will be an Horizontall in another place, whose Zenith is distant from that place 90. degrees, either Northward or Southward.

As for example : Let there be an Erect Diall made for any place whose latitude is 52. gr. this is nothing else, but to make an Horizontal Diall for the latitude of 38. degrees. And if there be an Erect Dial made for the latitude of 27. gr. the same will be an Horizontall Diall for the latitude of 63. degrees. The same proportion is to be observed in the rest. And hence it manifestly appeares, that an Horizontall Diall and a Verticall are the same, at the latitudes of 45. degrees.

And

And so likewise by this rule may be made any manner of Inclining Diall, if so be that the quantity of the Inclination be but known. As for example, if a Diall be to be made on a plaine ground, whose Inclination is 10. degrees from the Horizon South-ward, and for a place whose latitude is 52. *gr.* Northward: you must describe in that plaine an Horizontall Diall for the latitude of 62. degrees Northward. And if in the same latitude the Diall ground doe incline toward the North 16. *gr.* you must make an Horizontall Diall for the Northerne latitude of 36. *gr.*

And thus much shall suffice to have beene spoken of the making of Dials by the *Globe.*



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The fifth and last Part.

of the Rombes that are described in the
Terrestriall Globe, and their use.



These lines which a Ship, following the direction of the Magneticall Needle, describeth on the surface of the Sea, *Petrus Nonius* calleth in latine, *Rombes*, borrowing the Appellation of his Countrymen the *Portugals*. Which word, since it is now generally received by learned Writers to expresse them by: we also will use the same.

These *Rombes* are described in the *Globe* either by greater or lesser circles, or by certaine crooked winding lines. But Sea-men are wont to expresse the same in their Nauticall Charts by right lines. But this practise of theirs is cleane repugnant to the truth of the thing, neither can i by any meanes be defended from errors. The invention of *Rombes*, and practise of describing the same upon the *Globe*, is somewhat ancient. *Petrus Nonius* hath written much concerning the use of them, in two bookes which he intituleth, *de Navigandi ratione*. And *Mercator* hath also ex-

pressed them in his *Globes*. But the use of them is not as yet so well knowne to every body: and therefore I thinke it not unfit, to be the more large in the explication of the same.

Beginning therefore with the nature and originall of them, we shall afterward descend to the use there is to be made of them in the *Art of Navigation*. And first we will begin with the originall, and nature of the *Nauticall Index*, or *Compass*: which is very well knowne to be of the fashion of a plaine round Boxe, the circumference whereof is divided into 32. equall parts, distinguished by certaine right lines passing through the center thereof. One point of it, which that end of the Needle that is touched with the Magnet alwayes respects, is directed toward the North, so that consequently the Opposite point must necessarily respect the South. And so likewise all the other parts in it have respect unto some certaine fixed points in the Horizon: (for the *Compass* must alwayes be placed Parallel to the Horizon.) Now I call these points Fixed, onely for doctrine sake, not forgetting in the meane time that the *Magnetickall Needle*, (besides that it doth of it owne nature decline in divers places from the situation of the true Meridian, (which is commonly called the variation of the *Compass*) according to the custome of divers Countries is also placed after a divers manner in the *Compass*. For some there are that place it 5. gr. 37. m. more Eastward then that point that answereth to the North quarter

of the world: as doe the *Spaniards*, and our *Englishmen*. Some place it 3. gr. and almost 18. m. declining from the North: and some set it at 11. gr. 15. minutes distance from that point. All which notwithstanding, let us suppose the Needle alwayes to looke directly North and South. Now these lines thus expressed in the Mariners Compass, are the common Intersections of the Horizon, and Verticall circles, or rather Parallel to these. Among which, that wherein the Needle is situate, is the common Intersection of the Horizon and Meridian. And that which crosseth this at right angles, is the common section of the Horizon, and a verticall circle drawne through the Equinoctiall East and West. And thus we have the 4. Cardinall winds or quarters of the world, and the whole Horizon divided into 4. equal parts, each of them containing 90. degrees. Now if you divide again each of these into 8. parts, by 7. verticall circles, drawne on each side of the Meridian, through the Zenith: the whole Horizon will be parted into 32. equall sections: each of which shall containe 11. gr. 15. m. These are the severall quarters of the world observed by Mariners in their Voyages: but as for any lesser parts or divisions then these, they look not after them. And this is the originall of the Nauticall Compass, by which Sea-men are guided in their Voyages.

Let us now in the next place consider, what manner of lines a Ship, following the direction of the Compass, doth describe in her course.

For

For the better understanding whereof, I think it fit to premise these few Propositions: which being rightly and thoroughly considered, will make the whole businesse facile and perspicuous.

1 All Meridians of all places doe passe through both the Poles: and therefore they crosse the *Æquator*, and all Circles Parallel to it, at right angles.

2 If wee direct our course any other way then toward one of the Poles: we change ever and anon both our Horizon and Meridian.

3 The Needle being touched with the Loadstone, pointeth out the common Intersection of the Horizon and Meridian: and one end of it alwayes respecteth the North, in a manner, and the other the South. And here I cannot but take notice of a great error of *Gemma Frisius*, who in his Corollary to the fiftene Chapter of *P. Appians* Cosmography, affirms, that the Magneticall Needle respects the North Pole on this side of the *Æquinoctiall* line, but on the other side of the *Æquinoctiall*, it pointeth to the South Pole. Which opinion of his is contradicted by the experience both of my selfe, and others. And therefore, I beleeve, his too much credulity deceived him, giving credit perhaps to the fabulous relations of some vaine heads. But howsoever it be, the error is a sowlc one, and unworthy so great an Author. This frivolous conceit hath also beene justly condemned before, by the

the Illustrious *Jul. Scaliger*, instructed hereto out of the Navigations of *Ludovicus Verto-*
mannus, and *Ferdinand Magellane*.

4 The same *Rumbe* cutteth all the Meridi-
ans of all places at equall Angles, and respect-
eth the same quarters of the world in every
Horizon.

5 A greater circle drawne through the
vertex of any place, that is any whit distant
from the *Æquator*, cannot cut diverse Meridi-
ans at equall angles. And therefore I cannot
assent to *Pet. Nonius*, who would have the
Rumbes to consist of portions of greater cir-
cles. For seeing that the portion of a greater
circle, being intercepted betwixt diverse Me-
ridians, though never so little distant from
each other, maketh unequall angles with the
same, a *Rumbe* cannot consist of them, by the
precedent proposition. But this inequality of
Angles is not perceived (saith he) by the sense,
unlesse it bee in Meridians somewhat farre re-
mote from one another. Be it so. Notwith-
standing the error of this Position is disco-
verable by art and demonstration. Neither
doth it become so great a Mathematician, to
examine rules of Art by the judgement of the
sense.

6 A greater circle drawne through the
Verticall point of any place, and inclining to
the Meridian, maketh greater angles with all
other Meridians, then it doth with that from
whence it was first drawne. It therefore be-
hooveth, that a line, which maketh equall
angles

angles, with diverse Meridians, (as the *Rumbes* doe) be bowed and turne in toward the Meridian. And hence it is, that when a Ship saileth according to one and the same *Rumbe*, (except it be one of the foure Principle and Cardinall *Rumbes*) it maketh a crooked Spirall line, such as we see expressed in the Terrestriall *Globe*.

7 The portions of the same *Rumbe*, intercepted betwixt any two Parallels, whose difference of latitude is the same, are also equall to each other. Therefore an equall segment of the same *Rumbe*, equally changeth the difference of latitude in all places. And therefore that common rule of Sea-men is true: that in an equall space passed in one and the same *Rumbe*, one of the Poles is equally elevated, and the other depressed. So that *Michael Coignet* is found to be in an error, who out of some certaine ill grounded positions indeavoured to prove the contrary.

Out of the 4th Proposition there ariseth this Confectary; namely: That *Rumbes*, though continued never so farre, doe not passe through the Poles. For seeing that the same *Rumbe* is equally inclined to all Meridians; and all Meridians doe passe through the Poles: it would then follow, that if a *Rumbe* should passe through the Poles, the same line in the same point would crosse infinite other lines: which is impossible, because that a part of any Angle, cannot bee equall to the whole. Neither doth that, which we delivered in the last Proposition make any thing against this Confectary;

to wit, that betwixt any two Parallels of equall diſtance, equall portions of the ſame *Rumbe* may be intercepted; that ſo it ſhould thence follow, that the ſegment of any *Rumbe* intercepted betwixt the Parallel of 80. gr. of latitude and the Pole, is equall to a ſegment of the ſame *Rumbe* intercepted betwixt the Equator and the Parallel of tenne gr. of latitude: and the reaſon is, becauſe the Pole is no Parallel. And therefore it was a true Poſition of *Nonius*, That the *Rumbes* doe not enter the Poles: although it was not demonſtrated with the like happy ſucceſſe. For hee aſſumes foundations contrary to the truth: as wee ſaid before. And *Gemma Friſius* alſo was miſtaken, when hee affirmed, in his *Append. ad 15. cap. Appian: Cosmogr.* that the *Rumbes* doe concur in the Poles: which was the opinion alſo of ſome others who are therefore juſtly taxed by *Michael Coignet*.

Theſe things being well conſidered, it will be eaſie to underſtand, what manner of lines a Ship, following the direction of the Magnet, doth deſcribe in the Sea. If the forepart of the Ship, be directed toward the North or South, which are the quarters that the Magneticall Needle alwayes pointerh at: your courſe will be alwayes under the ſame Meridian: becauſe, as wee ſhewed in our third Proposition, the Needle alwayes reſpecteth the Interſections of the Horizon and Meridian, and is ſituate in the plaine of the ſame

same Meridian. If the forepart of the Ship be directed to that quarter that the East and West *Rumbe* pointeth out : in your course you wil then describe either the *Æquator*, or a circle Parallel to it. For if at the beginning of your setting forth, your Zenith be under the *Æquator*, your Ship will describe an Arch or segment of the *Æquator*. But if your Verticall point be distant from the *Æquator* either Northward or Southward ; your course will then describe a Parallel, as farre distant from the *Æquator*, as the latitude of the place is whence you set forward at first. As suppose our intended course to bee from some place lying under the *Æquator*, by the *Rumbe* of the East and West : we shall goe forward still under the *Æquator*. For by this meanes, as we goe on, we alwayes meet with a new Meridian, which the line of our course crosseth at right angles. Now no other line, besides the *Æquator*, can doe this : as appeares manifestly out of the Corollary of the first proposition. And therefore in this course our Ship must describe a portion of the *Æquator*. But if we steere our course by the East and West *Rumbe* from any place that lyeth besides the *Æquator* : we shall be alwayes under the same Parallel. For all circles Parallel to the *Æquator*, doe cut all the Meridians at right Angles, by the Corollary of the first Proposition. And although the fore part of the Ship alwayes respecteth the *Æquinoctiall* East or West, or intersection of the *Æquator* and Horizon :

yet

yet in our progresse we shall never come neare the Equator, but shall keepe alwayes an equall distance from it. Neither shall we come at all thither, whether the fore part of our ship looketh; but shall keep such a course, wherein we shall have ever and anon a new Meridian arising, which we shall crosse at equall Angles, and so necessarily describe a Parallel. But if our voyage be to be made under the *Rumbe* which inclineth to the Meridian: our course will then be neither in a greater nor lesser circle, but we shall describe a kind of crooked spirall line. For if you draw any Greater circle through the Vertex of any place, inclining to the Meridian, the same circle will crosse the next Meridian at a greater angle, then it did the former: by the 6. proposition. And therefore it cannot make any *Rumbe*: because the same *Rumbe* cutteth all Meridians at equall Angles, by the fourth Proposition. And all the Parallels, or lesser circles, doe crosse the Meridians at right Angles, by the Corollary of the 1. Proposition: and therefore they doe not incline to the Meridian.

Concerning those lines which are made in Sea voyages by the direction of the Compass and Magneticall Needle; *Gemma Frisius* in his appendix to the fifteenth Chapter of *Appians Cosmography*, part 1. speakes thus. *Verum hoc obiter annotandum, &c.* And (saith he) I think it not amisse to note this by the way, that the voyages on land doe differ very much from those that are performed at Sea. For those are under-

understood to be performed by the greater circles of the Sphere, as it is rightly demonstrated by *Wernerus*, in his Commentaries upon *Ptolomy*. But the voyages by Sea are for the most part crooked: because they are seldom taken in a great circle, but sometimes under one of the Parallels; when the Ship steers her course toward East or West: and sometime also in a greater circle: as when it saileth from North to South, or contrariwise: or else under the *Æquator*, either direct East. But in all other kinds of Navigation, the journeyes are Crooked, although the Magnet, and are neither like great circles, nor yet to Parallels: nor are they great circles at all, but onely a kind of small circles all of them at length come to the Poles. Thus hee: and in like manner in all the rest, save onely these lines to meet in the Pole: which we have already proved, is altogether contrary to the nature of *Rumbes*.

Hitherto have we spoken of the originall and nature of *Rumbes*: let us now see what use there is of them in the *Terrestrial Globe*.

Of the use of *Rumbes* in the *Terrestrial Globe*, there are three things to be considered. First, the use of *Rumbes* in the determination of the position of a place. Secondly, the use of *Rumbes* in the determination of the distance of a place. Thirdly, the use of *Rumbes* in the determination of the direction of a place.

Of the use of Rumbes in the Terrestriall Globe.

IN the Art of Navigation, which teacheth the way and manner how a Ship is to be directed in sayling from one place to another, there are foure things especially to be considered. And these are, the longitudes of the places, the latitudes, or differences of the same the *Rumbe*, the space or distance betwixt any two places measured according to the practise used by the Geographer one way, and by the Mariner another. For the former measures the distances of places alwayes by great circles, as after *Wernerus, Ptolemy* hath illustrated in his booke, *De Dimensionibus* but the Mariners course being made by portions of greater circles, sometimes of lesser, but for the most part of crooked lines: it is good reason that hee should measure the distances also of places by the same. Which, and how many of these are to be knowne before hand, that the rest may be found out, comes in the next place to be considered. Now the places betwixt which our voyage is to be performed, doe differ either in longitude onely, or in latitude only, or in both.

If they differ only in latitude, they are both under the same Meridian: and therefore it is

understood to be performed by the greater circles of the Sphere; as it is rightly demonstrated by *Wernerus*, in his Commentaries upon *Ptolomy*. But the voyages by Sea are for the most part crooked: because they are seldom taken in a great circle, but sometimes under one of the Parallels; when the Ship steers her course toward East or West: and sometime also in a greater circle: as when it saileth from North to South, or contrariwise: or else under the *Aequator*, either direct East, or west; But in all other kinds of Navigations, the journeyes are Crooked, although guided by the Magnet, and are neither like to greater circles, nor yet to Parallels: nor indeed are circles at all, but onely a kind of crooked lines, all of them at length concurring in one of the Poles. Thus hee: and indeed very rightly in all the rest, save onely that he will have these lines to meet in the Pole: which, as we have already proved, is altogether repugnant to the nature of *Rumbes*.

Hitherto have we spoken of the originall and nature of *Rumbes*: let us now see what use there is of them in the Terrestriall Globe.

of

Of the use of Rumbes in the Terrestriall Globe,

IN the Art of Navigation, which teacheth the way and manner how a Ship is to be directed in sayling from one place to another, there are foure things especially to be considered. And these are, the longitudes of the places, the latitudes, or differences of the same the *Rumbe*, and the space or distance betwixt any two places, measured according to the practise used in Sea voyages. For the distances of places are measured by the Geographer one way, and by the Mariner another. For the former measureth the distances of places alwayes by greater circles; as after *Wernerus*, *Pencrus* hath also demonstrated in his booke, *De Dimensione Terra*. But the Mariners course being made up sometimes of portions of greater circles, and sometimes of lesser, but for the most part of crooked lines: it is good reason that he should measure the distances also of places by the same. Which, and how many of these are to be knowne before hand, that the rest may be found out, comes in the next place to be considered. Now the places betwixt which our voyage is to be performed, doe differ either in longitude onely, or in latitude only, or in both.

If they differ only in latitude, they are both under the same Meridian: and therefore it is

the North or South *Rumbe*, that the course
 to be directed by. And there only then remaineth
 to know the difference of latitude, and
 distance betwixt these two places: One
 which being knowne, the other is easily found
 out. For if the difference of latitude be given
 in degrees and minutes, as Sea-men use
 to doe, the number of degrees and minutes be-
 ing multiplied by 60. (which is the number
 of English miles that we commonly allow
 to a degree, and that according to *Ptolemies* opi-
 nion, as we have already demonstrated :) the
 whole number of miles made in the voyage
 betwixt these places will appear. And if you
 multiply the same number of degrees by seven-
 teene and an halfe, you have the same distance
 in Spanish leagues. And so contrariwise, if the
 distance in miles or leagues be knowne, and
 you divide the same by 60. or seventene and
 an halfe, the quotient will shew the number of
 degrees and minutes, that answer to the dif-
 ference of latitude betwixt the two places
 assigned. As for example. If a man were to
 saile from the *Lizard* (which is the outmost
 point of land in *Cornwall*) Southward, till
 he come to the Promontory of *Spain*, which
 is called *C. Ortegal*; the difference of lati-
 tude of which places is 60. gr. 10. minutes:
 if you desire to know the distance of miles be-
 twixt these places, multiply sixe gr. teene m.
 by 60. and the product will be 370. the num-
 ber of English miles betwixt the two places
 assigned. And this account may be much more
 truly

truely and readily made by our English miles, In as much as 60. of them are equivalent to a degree, so that one mile answereth to one minute: by which meanes all tedious and prolix computation by fractions is avoyded.

In the next place let us consider those places that differ only in longitude: which if they lye directly under the Equinoctiall, the distance betwixt them being knowne, the difference of longitude will also bee found: or contrariwise, by multiplication or division, in like manner as the difference of latitude is found. But if they be situate without the Equator, we must then goe another way to worke. For seeing that the Parallels are all of them lesse then the Equator, all of them decreasing in quantity proportionably, till you come to the Pole, where they are least of all; hence it comes to passe, that there can be no one certaine determinate measure assigned to all the Parallels. And therefore the common sort of Mariners doe greatly erre, in attributing to each degree of every Parallel, an equal measure with a degree of the Equator. By which means there have been very many errors committed in Navigation, and many whole Countreyes also removed out of their owne proper situation, and translated into the places of others.

That therefore there might bee provision made in this behalfe, for those that are not so well acquainted with the Mathematicques: I have added a Table, which sheweth, what proportion

portion a degree in every Parallel beareth to a degree in the Equator: whence the proper measure of every Parallel may bee found. In which Table the first Colume proposeth the severall Parallels, each of them differing from other one degree of latitude. The second sheweth the minutes and seconds in the Equator, that answer to a degree in each Parallel: which if you convert into miles, you shall know how many miles answer to a degree in every Parallel.

M. S.	M. S.	M. S.	M. S.	M. S.
1 59 59	27 53 27	50 38 34	71 19 31	90 0 0
2 59 57	28 52 58	51 37 46	72 18 31	
3 59 55	29 52 28	52 36 56	73 17 31	
4 59 51	30 51 57	53 36 6	74 16 31	
5 59 46	31 51 25	54 35 16	75 15 30	
6 59 40	32 50 52	55 34 24	76 14 28	
7 59 33	33 50 18	56 33 31	77 13 26	
8 59 25	34 49 44	57 32 40	78 12 24	
9 59 19	35 49 8	58 31 47	79 11 22	
10 59 5	36 48 32	59 30 53	80 10 20	
11 58 53	37 47 51	60 29 59	81 9 18	
12 58 41	38 47 17	61 29 5	82 8 16	
13 58 27	39 46 38	62 28 11	83 7 14	
14 58 13	40 45 54	63 27 14	84 6 12	
15 57 57	41 45 17	64 26 18	85 5 10	
16 57 40	42 44 33	65 25 22	86 4 8	
17 57 22	43 43 52	66 24 24	87 3 6	
18 57 3	44 43 8	67 23 26	88 2 4	
19 56 43	45 42 24	68 22 28	89 1 2	
20 56 20	46 41 40	69 21 30		
21 56 0	47 40 55	70 20 31		
22 55 37	48 0 9			
23 55 13	49 39 32			
24 54 48				
25 54 22				
26 53 55				

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By the use of this Table, if a Ship have sailed under any Parallel, and the space be knowne how farre this Ship hath gone, the difference of Longitude may be found by the rule of proportion: and so contrarywise, if the difference of Longitude be given, the distance will in like manner bee knowne. As for example. Suppose a Shippe to have set forth from *E. Dalgur*, (which is a Promontory on the West part of *Africke*) and sailed Westward, 200. English Leagues, that is to say, 600. miles. We desire now to know the difference of Longitude betwixt these two places. That Promontory hath in Northern latitude 30. degrees. Now to one degree in that Parallel answer 51. *m.* 57. *sec.* that is to say, 51. miles, and fifty seven sixtieth parts of a mile. Thus therefore we dispose our proportionall terms, for the finding of the difference of Longitude, 51. miles, 57. min. (or suppose 52. full miles, because the difference is so small) give one degree; therefore 600. give 11²¹. gr. which is the difference of Longitude betwixt the place whence the Ship set forth, and that where it arrived. But the termes are to be inverted, if the difference of Longitude be given, and the distance be to be sought. But this is not so congruous. For we never use by the knowne Longitude to finde the distance: but the contrary. Neither indeed have we as yet any certaine way of observing the difference of Longitudes: however some great boasters make us large promises of the same. But,

Expectata seges variis delictis avariis.

It remaineth now to speake of those places that differ both in Longitude and Latitude: wherein there is great variety, and many kinds of differences. Of all which there are foure (as we have already said) especially to be considered: and these are the differences of longitude, and of latitude, and the distance, and *Rumbe* by which the voiage is performed. Two of which being knowne, the rest may readily be found out. Now the transmutation of the things to be granted for knowne, and to be enquired after in these foure termes, may be proposed sixe manner of wayes, as followeth.

The difference of { Longitude and Latitude } being known: { The Rumbe and Distance } may also be found.

The difference of { Longitude and the Rumbe } being known: { The Difference of latitude and Distance } may be found.

The difference of { Longitude and Distance } being known: { The Difference of Latitude and Rumbe } may be found.

The difference of { Latitude and Rumbe } being known: { The Difference of longitude and Distance } may be found.

The difference of { Latitude and Distance } being known: { The Rumbe and Difference of longitude } may be found.

The { Rumbe and Distance } being known: { the difference of Longitude and Latitude } may be found.

Thus

Thus you see that any two of these being knowne, the other two may also be found out. Now most of these (yea all of them, that are of any use at all) may be performed by the Globe. And let it suffice to have here given this generall advertisement once for all.

Now beside these things here already to be knowne: it is also necessary that we know the latitude of the place whence we set forth, and the quarter of the world that our course is directed unto: for otherwise we shall never be able rightly to satisfie these demands. And the reason is, because that the difference of longitude and latitude is alwayes wont to be reckoned unto the two parts of the world: some of them to the North and South, and the rest to the East and West. And especially, because that from all parts of the Meridian, and from each side thereof, there are *Rumbes* drawne that are all of equall angles or inclinations. So that unlessse the quarter of the world be knowne, whereto our course tendeth, there can be no certainty at all in our conclusions. As if the difference of latitude be to be enquired after: the same may indeed be found out; but yet we cannot determine, to which quarter of the world it is to be reckoned, whether North or South. And if we seek for the difference of longitude: this may be found: but in the meane time we shall not know, whether it be to be reckoned toward the East or West. And so likewise when the *Rumb* is sought for, we may perhaps find what inclination

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Thus

nation it hath to this Meridian: but yet we cannot give it its true denomination, except we know toward what quarter of the world one place is distant from the other. For from each particular part of the Meridian, the *Rumbes* have equall inclinations. These grounds being thus laid, let us now proceed to the examination of each particular.



I. *The difference of Longitude and Latitude of two places being knowne, how to find out the Rumb and Distance of the same.*

Turne about the Globe, untill that some *Rumb* or other do crosse the Meridian, at the latitude of the place whence you set forth. Then againe turne about either toward the East or West, as the matter shall require, untill that an equall number of degrees in the Equator to the difference of longitude of the two places do passe the Meridian. Then afterward looke whether or no the aforesaid *Rumb* doe crosse the Meridian at the latitude of the place, where you are: for if it doe so, you may then conclude, that it is the *Rumb* you have gone by: but if otherwile, you must take another, and try it in like manner, till you light upon one that will do it.

As for example. *Serra Lioma* is a Promontory of *Affricke*, having in latitude 15. gr. 20. m. and in Northerne latitude 7. gr. 30. m. Suppose that we are to saile to the Isle of *Saint Helens*, which hath in longitude 24. gr. 30. and in Southerne latitude 15. gr. 30. m. I now demand, what *Rumbe* we are to saile by : and thus we finde in this manner. I first apply to the Meridian the 356. gr. 40. m. of longitude : and withall observe what *Rumbe* the Meridian doth crosse at the latitude Northerne of 7. gr. 30. m. (which is the latitude of the place whence we are to set forth :) and I finde it to be the North norwest, and South Southeast *Rumbe*. Then I turne about the Globe toward the West, (because *Saint Helens* is more Eastward then *Serra Lioma*) untill that 9. gr. 10. m. in the *Equator* (which is the difference of longitude betwixt these two places) do crosse the Meridian. And in this position of the Globe, I finde that the same *Rumbe* is crossed by the Meridian in the Southerne latitude of 15. gr. 30. m. which is the latitude of *Saint Helens* Ile. Therefore I conclude, that this is the *Rumbe* that we are to go by, from *Serra Lioma* to *Saint Helens*. And in this manner you may finde the *Rumbe* betwixt any two places, either expressed in the Globe, or otherwise : so that the difference of longitude and latitude be but knowne.

If the places be expressed in the Globe betwixt which you seeke the *Rumbe* ; you must then with your Compasses take the distance betwixt

betwixt the two places aligned, and apply the same to any *Rumbe* that you please (but only in those places where they crosse the Parallels of latitude of the said places) til you find a *Rumbe*, whose portion intercepted betwixt the Parallels of the two places, shal agree to the distance intercepted by the Compasses. As for example. If you would know what a *Rumbe* leadeth us from *C. Cantin*, a Promontory in the West part of *Africke*; having in latitude 32. gr. 20. m. to the *Canary* Islands, which are in the 28. gr. of latitude. First, you must apply the distance intercepted betwixt the two places to any *Rumbe*, that lyeth betwixt the 28. and 32. gr. 30. m. of latitude, which are the latitudes of the places assigned; and you shall find that this distance being applyed to the South South-west *Rumbe*, so that one foot of the Compasses be set in the latitude of 32. gr. 20. m. the other will fall on the 28. gr. of latitude in the same *Rumbe*. Whence you may conclude, that you must saile from *C. Cantin* to the *Canary* Islands by the South South-west *Rumbe*. There are some that affirme, that if this distance intercepted betwixt two places, be applyed to any *Rumbe* where they all meet together at the *Equator*, the same may be performed. But these men have delivered unto us their owne errours, in stead of certaine rules. For suppose it be granted, that the portions of the same *Rumbe* intercepted betwixt two Parallels equidistant from each other, are also equall in any part of the *Globe*: yet notwithstanding

standing they are not to be measured by such a manner of extension. For the *Rumbes* that lye neare the *Aequator*, differ but little from greater circles : but as they are farther distant from it, so they are still more crooked, and inclining to the Meridian.

The *Rumbe* being found, wee are next to seeke the distance betwixt the two places. *Nomius* teacheth a way to doe this, in any *Rumbe*, by taking with your Compasses the space of 10. leagues, or halfe a degree. Others take 20. leagues, or an whole degree. But I approve of neither of these, nor yet reject either. Only I give this advertisement by the way : that according to the greater or lesse distance of the places from the *Aequator*, a greater or lesse measure may be taken. For neare the *Aequator*, where (as we have said) the *Rumbes* are little different from greater circles ; you may take a greater measure to goe by. But when you are farre from the *Aequator*, you must then take as small a distance as you can ; because that here the *Rumbes* are very crooked. And yet the distance of places may be much more accurately measured, (so that the *Rumbe* and difference of latitude of the same bee but knowne) by this Table here set downe ; which is thus.

<i>Rumbes</i>	<i>Degr.</i>	<i>Min.</i>	<i>Sec.</i>	
<i>First</i>	1	1	10	
<i>Second</i>	1	4	56	<i>Answer to a</i>
<i>Third</i>	1	12	9	<i>degree in the</i>
<i>Fourth</i>	1	24	51	<i>Equator, or</i>
<i>Fifth</i>	1	47	59	<i>Meridian.</i>
<i>Sixth</i>	2	36	47	
<i>Seventh</i>	5	7	33	

In this Table you have here set downe, how many degrees, minutes, and seconds in every *Rumbe*, do answer to a degree in the Meridian or Equinoctiall. Now a Degree (as we have often said,) containeth 60. miles: so that each mile answereth to a minute, and the sixtieth part of a mile, or seventeenth paces, to every second. So that by the helpe of this Table, and the rule of proportion, the distance of any two places, in any *Rumbe* assigned (if so be that their latitudes be known) may easily be measured: and so on the contrary, if the distance be knowne, the difference of latitude may be found. As for example. If a Ship have sailed from *C. Verde*, in *Africke*, lying in the 14. gr. 30. m. of Northerne latitude, to *C. Saint Augustine* in *Brasile*, having in Southerne latitude 8. gr. 30. m. by the *Rumbe* of Southwest and by South: and it be demanded what is the distance or space betwixt these two places. For the finding of this we dispose our termes of proportion after this manner. 1. gr. of latitude in this *Rumbe*, (which is the third from the Meridian)

dian) hath 1. gr. 12. m. 9. sec. that is to say, 72 $\frac{1}{2}$ miles : therefore 23. gr. (which is the difference of latitude betwixt *C. Verde* and *C. Saint Augustine*) require 1659. miles and almost an halfe, or something more then 553. English leagues. So that this is the distance betwixt *C. Verde* and *C. Saint Augustine*, being measured in the third *Rumbe* from the Meridian.



II. The *Rumbe* being knowne, and difference of longitude; how to finde the difference of latitude and distance.

TO find out this, you must turne the Globe, till you meete with some place, where the said *Rumbe* crosseth the Meridian at the same latitude that the place is of, where you set forth. And then turning the Globe either Eastward or Westward, as you see cause, untill that so many degrees of the Equator have passed the Meridian, as are answerable to the difference of longitude betwixt the two places; you must marke what degree in the Meridian the same *Rumbe* cutteth. For that degree sheweth the latitude of the place, you are arrived.

As for example. The Ile of *Saint Philip* hath in longitude 24. gr. 20. m. and in Southern

therne latitude 15. gr. 30. m. Suppose therefore a Shippe to have sailed West North-west, to some place that lyeth West from it 24. degrees. We demand what is the latitude of this place. First therefore we set the Globe in such sort, as that this *Rambe* may cross the Meridian at the 15. gr. 30. m. of Southerne latitude, which is the latitude of *Saint Helens*: and this will happen to be so, if you apply the 37. gr. of longitude to the Meridian. Then we turne about the Globe Eastward, till that 24. gr. of the Equator have passed under the Meridian. And then marking the degree of the Meridian, that the same *Rambe* crosseth, we finde it to be about the 5. gr. 30. m. of Southerne latitude. This therefore we conclude to be the latitude of the place where we are arived.

And by this meanes also the distance may easily be found, if the *Rambe* and difference of latitude be first knowne.



III. The

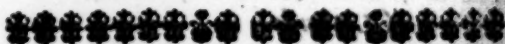


III. *The difference of Longitude and
distance being given : how to
finde the Rumb, and difference
of Latitude.*

THere is not any thing in all this
Art more difficult and hard to
bee found, then the *Rumb*
out of the distance and dif-
ference of *LONGITUDE* given. Nei-
ther can it bee done upon the *GLOBE*,
without long and tedious practise, and
many repetitions and mensurations. The
practise hereof being therefore so prolix,
and requiring so much labour : it is the
lesse necessary, or indeed rather of no
use at all. And the reason is, because
the difference of *LONGITUDE*, as
wee have already shewed, is so hard to
bee found out. The invention whereof
I could wish our great boasters would
at length performe : that so wee might
expect from them something else, besides
bare words, vaine promises, and empty
hope.

Some

Some of these conclusions also which we have here set downe, are, I confesse, of no great use or necessity, out of the like supposition of the difference of latitude. Notwithstanding, for as much as the practise of them is easie & facile, I have willingly taken the paines, for exercise sake onely, to propose them.



IV *The difference of latitude and Rumb being given, how to finde the difference of longitude and distance*

First set your Globe so, as that the *Rumb* assigned may crosse the Meridian at the same latitude that the place is of, whence you set forth. And then turne about the Globe toward the East or West, as neede shall require, till that the same *Rumb* shall crosse the Meridian at the equall latitude of that place whither you have come. And so marking both places, reckon the number of degrees in the *Æquator*, intercepted betwixt both their Meridians. And this shall be the difference of longitude betwixt the same places. As for example, *C. D'alguer* in *Africke* hath about 30. gr. of Northerne latitude. From whence suppose a Ship to have sailed North-

West and by West, to the thirtie eight *gr.* of Northerne latitude also. Now wee demand, what is the difference of longitude betwixt these two places? Turning therefore the *Globe*, till the Meridian crosse the said *Rumbe* at the thirtieth *gr.* of Northerne latitude, (which will bee, when the seventh *gr.* of longitude toucheth the Meridian,) I turne it againe toward the East, untill such time as the Meridian crosseth the same *Rumbe* in the thirtie eighth *gr.* of Northerne latitude; which will happen, when the three hundred fiftie second *gr.* of longitude commeth to the Meridian. Whence wee conclude, that the place where the Shippe is arived, is Westward from *C. D'alguer* about fiftene degrees. And the Meridian of that place passeth through the Easterne part of Saint *Michaels* Island, one of the *Azores*. Now how the distance may be found, the *Rumbe* and difference of latitude being knowne, hath beene declared already in the first proposition.

V

V. The



V. *The difference of Latitude, and distance being given, the Rumbe and difference of longitude may be found.*

THe *Rumbe* may easily be found out, by the Table which we have before set downe. But an Example will make the matter more cleare. If a Ship have sailed from the most Western point of *Africke*, commonly called *C. Blanco*, (which lyeth in the 10. *gr.* 30. *m.* of Northerne latitude) betwixt North and West, for the space of 1080. miles, and to the 20. *gr.* 30. *m.* of Northerne latitude also: and it be demanded, by what *Rumbe* this course was directed: for answer hereof, we proceed thus. The difference of latitude is 10. *gr.* and the distance betwixt these places 1080. miles: We therefore dispose our tearmes thus, 10. *gr.* containe 1080. miles: therefore 1. *gr.* containeth 108. miles. Which if we divide by 60. we shall finde in the quotient 1. *gr.* 48. *m.* which number if you seeke in the Table, you shall finde it answering the fifth *Rumbe*. Neither is the difference betwixt that number in the Table, and this here of ours above one second scruple. So that we may safely pronounce, that this voyage was performed by the fifth *Rumbe* from the Meridian, which is North west and by west.

Now

Now the *Rumbe* being found, and the difference of latitude knowne, you may finde out the difference of longitude by the second proposition.



VI. *The Rumbe and distance being given, the difference of Longitude and Latitude may also be found.*

THis also may easily be performed, by the help of the former Table. And therefore wee will only shew an example how it is to bee done. From the *Cape of good Hope*, which is the most Southernly point of *Africa*, and hath in Southerne latitude about 35. degrees, a Ship is supposed to have sailed North North-west (which is the second *Rumbe* from the Meridian) above 642. miles, or if you will, let it be full 650. Now we demand the difference of latitude betwixt these two places: and this is found after this manner. First, we take the degrees and minutes that answer to a degree of latitude in the second *Rumbe*, and turne them into miles. And then we finde the number of these to be 64. miles 56. minutes, for which let us take full 65. miles. Now therefore our tearmes are thus to be disposed: 65. miles answer to 1. degree of latitude: therefore 650. will be equivalent to ten degrees of latitude.

Which if you subtract from 35. (which is the latitude of the place, whence the Shippe set forth) because the course tends toward the Æquator: the remainder will be 25. gr. of Southerne latitude: which is the latitude of the place, where the Ship is arrived.

Now the *Rumbe* being knowne, and the difference of latitude also found; the difference of longitude must be found out by the second Proposition.

FINIS.

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Imprimatur.

Tbo. Wykes R. P.
Epif: Lond. Capel. Domest.
May 11^o 1638.

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